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August 1968

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SUMMARY

This document presents a detailed analysis of the resonant perturbations to the 20th degree and order on 83 existing satellites. This analysis reveals that terms of order (m) 2 and 12-14 are well represented by existing resonant satellites. Only a few resonances for the other orders are available.

The study also shows that for resonant orbits with beat periods less than about 15 days, the frequencies contributed by the terms resonant with an orbit are all nearly the same, making such orbits of limited value for geodesy if considered individually. This situation is aggravated for orbits at or near the critical inclination.

The phenomenon of shallow resonance has also been studied. The results of this study, presented in Appendix A, show that to accurately analyze resonant orbits, considerable attention to calculation of mean mean motion is necessary. Highly accurate formulae to calculate mean mean motion have been derived and are presented in this appendix.



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A PERTURBATION ANALYSIS OF EXISTING RESONANT SATELLITES

INTRODUCTION

The orbits of numerous resonant or near-resonant satellites have been studied and amplitudes of along-track perturbations and the corresponding beat periods have been estimated. The majority of these orbits are resonant with geopotential terms of order (m) 2 and 12-14, while only occasional useful resonances for the other orders are available. Except for satellites with $s = 2$ revs/day, all harmonic components (ℓ, m, p, q) are shown that cause effects along track ≥ 50 meters in magnitude. For $s = 2$ revs/day, only effects larger than 10 km are presented.

Increasing interest in the use of orbits in shallow resonance for geodesy is evident. Much of this interest is directed toward analyzing long-periodic variations in orbital elements. To aid in such analyses, a detailed discussion of shallow resonance is presented.

CALCULATION OF PERTURBATIONS

C. A. Wagner's study (Reference 1) of the Satellite Situation Reports, issued by Goddard Space Flight Center, revealed many resonant or near-resonant orbits of interest for geodesy. These satellites have been further analyzed and this paper reveals the fine spectra of the resonant perturbations.

Perturbations of the quantity $\Omega \cos i + \omega + M =$ Central Angle (CA) have been calculated by Kaula's formulas (Appendix B) and multiplied by the semi-major axis of the orbit to obtain an estimate of the transverse component of the orbital perturbations.¹ Kozai's formula (Reference 3) for the mean mean motion of a satellite was used to compute the beat periods to insure consistency with the NORAD elements. Köhnlein's geopotential constants (Reference 4) in Table 3, complete to (15, 15), were used in these calculations. This set was selected only because of its completeness. For degree (ℓ) > 15 , the value $\bar{J}_{\ell m} \approx .07 \times 10^{-6}$, suggested by Kaula (Reference 2), was employed. This choice probably over-emphasizes some of the perturbations, so that it is unlikely that any significant

¹(Ω is the right ascension of the ascending node, i is the inclination, ω is the argument of perigee of the orbit, and M is the mean anomaly of the satellite)

effects have been missed up to the degree and order of this study. Perturbations of the semi-major axis have also been computed.

The condition for shallow resonance is approximately the near commensurability between the mean motion of a satellite and an integer times the rotation rate of the Earth. However, as shown in Appendix A and Reference 2, a more precise definition of resonance is:

$$\dot{D}_{\ell_{mpq}} \triangleq (\ell - 2p) \dot{\omega} + (\ell - 2p + q) \dot{M} + m (\dot{\Omega} - \dot{\theta}) \approx 0 \quad (1)$$

where

$\dot{\theta}$ is the rotation rate of the Earth and (p,q) identify a particular component of the harmonic expansion of a tesseral harmonic (ℓ,m)

This definition produces results more useful in analyzing shallow resonance. When beat periods $(D_{\ell_{mpq}}/360^\circ)^{-1}$ are small, i.e., < about 15 days, the beat periods of the various components for the resonant terms of an eccentric orbit will be similar. This situation is unfavorable for separating the effects of the various constants. However, eccentric orbits sufficiently far from the critical inclination $i = 63.40$, with moderate or long beat periods have a rich spectrum of frequencies which will certainly help to determine the constants. Circular orbits in shallow resonance or orbits at the critical inclination have only one frequency for all resonant terms of a given order; thus, it becomes more difficult to recover the constants from observations of such orbits.

TABLES OF RESONANT PERTURBATIONS

Table 1 presents a summary of available information (References 5 and 6) on about 83 of the Satellites in Reference 1.

The tables of resonant orbits in this document were computed subject to some limitations. For the 12 hour satellites, only terms causing perturbations in excess of 10^4 meters are shown. In the other cases, 50 meters is the minimum perturbation shown. Also there was no attempt to compute resonances higher than the 20th order. Thus, tables which stop at the 20th degree and order probably indicate that even higher resonances exist.

The orbital elements on each table are the mean elements of 15 April 1968. The indicated value of s revs/day is the nearest integer. In addition to the beat period, geocentric angle (CA) and transverse perturbation estimates, an estimate of the perturbation of the semi-major axis is shown. This last quantity should be valuable to contemplated investigations into variations of mean orbital elements.

Table 1
Resonant Satellite Data

S(Revs/ Day)	Satellite No.	Code Name Identification	Responsible Agency	Perigee Height (km, Apr. '68)	Shape	Dimension (m)		Area to Mass Ratio (cm ² /gm)	
						Length x Diameter	Weight (kg.)	(A/M) Max.	(A/M) Min.
15	1968-015B			267	-	-	-	-	-
15	1968-006A	Cosmos 200	USSR	516	-	-	-	-	-
15	1968-006C			503	-	-	-	-	-
15	1967-42A	Ariel 3	UK	475	-	-	-	-	-
14	1968-028B	-	-	139	-	-	-	-	-
14	1962-25C	-	-	600	-	-	-	-	-
14	1963-26A	-	USA F	412	Cyl	2.54 x 0.592	99.3	0.1514	0.02772
14	1962-02B Beta 2	Tiros 4 Rocket	USSR	700	Cyl	1.5 x 0.46	23	0.30	0.07227
14	1963-43A	Polyot 1	USSR	335	-	-	-	-	-
14	1960-07A Eta 1	Transit 2A	USN	615	Sph	0.91	101	0.2828	-
14	1966-25D	OV1-4 Rocket	USA F	886	Cyl	2.05 x 0.72	70	0.2109	0.05816
14	1960-09A Iota 1	Echo 1	NASA	730	Infl. Sph.	30	62	11.402	-
14	1963-09A Iota 1	Explorer 7	NASA	551	Doub. Cone	0.76 x 0.76	41.5	0.1093	0.06959
14	1966-25A	OV1-4	USA F	887	Hemisphere + Cyl	1.4 x 0.69	87.6	0.08524	0.002134
14	1963-54C	-	NASA	697	Fragments	-	-	-	-
14	1964-26A	Blue Scout Transit	USN	854	-	-	60	-	-
14	1966-31B	OAO 1 Rocket	NASA	787	Cyl	6 x 1.5	700	0.1286	0.025248
14	1965-81A	OGO 2	NASA	419	Box & Booms	1.82 x 0.91	520	0.03185	0.01593
14	1964-31A	Thor Agena Rocket	USA F	828	Cyl	8 x 1.5	-	-	-
14	1964-51B	Explorer 20 Rocket	NASA	867	Cyl	1.5 x 0.46	24	0.2875	0.06925
14	1964-01A	Agena Rocket	USN/USA	910	Cyl	6 x 1.5	1000	0.09	0.01767
14	1964-51A	Explorer 20	NASA	867	Doub. Cone	0.83 x 0.66	44	0.0777	0.06225
14	1965-16A	Greb (SR6)	USN/USA F	907	Sph	0.6	40	0.0695	-
14	1961-15A	Transit 4A	USN	883	Cyl	0.78 x 1.09	79	0.1181	0.109
14	1964-76A	Explorer 24	NASA	505	Inf. Sph.	3.65	8.6	12.168	-
14	1961-15B OMI 2	Injun-Sr-3	USN	884	Sph-Cyl	0.51	25-16	-	-
14	1964-64A	Explorer 22	NASA	887	Octa	0.30 x 0.46	52	0.0319	0.026
14	1958 01A Alpha 1	Explorer 1	NASA	339	Cyl	2.03 x 0.15	18.77	0.1622	0.09416
14	1967-11A	Diadem 1	FRANCE	566	-	-	-	-	-
13	1968-011B	-		1185	-	-	-	-	-
13	1965-27A	Atlas Agena	USA F/USA	271	Cyl	11 x 1.5	2000	0.06762	0.00724
13	1965-27C	-	USA F/USA	1240	-	-	-	-	-
13	1967-14A	Diadem 2	FRANCE	587	-	-	-	-	-
13	1968-002B	Geos 2 Rocket	-	1083	-	-	-	-	-
13	1968-002A	Geos 2	-	1084	-	-	-	-	-
13	1960-14A XI 1	Explorer 8	NASA	416	Doub. Cone	0.7 x 0.76	41	0.1107	0.07044
13	1962-60A B MU 1	Anna 1B	USN	1075	Spheroid	0.91 x 1.22	161	0.0726	0.05416
13	1963-53A	Explorer 19	NASA	767	Inf. Sph.	3.65	7	14.95	-
13	1965-32A	Explorer 27	NASA	941	Octa	0.30 x 0.46	60	0.0274	0.023
13	1963-38C	SN-39	USA F/USN	1104	-	-	61	-	-
13	1963-49B	Thor Able Star	USA F/USN	1051	-	-	-	-	-
13	1965-48A	Transit	USN	1028	-	-	-	-	-
12	1961-04B Delta 2	Explorer 9 Rockets	NASA	633	Cyl	1.83 x 0.46	24	0.3508	0.06925
12	1966-13A	D-1A	FRANCE	508	Cyl	0.2 x 0.5	19	0.1033	0.05263
12	1966-13B	D-1B Rocket	FRANCE	500	Cyl	2.1 x 0.65	68	0.2007	0.04879
12	1965-89C	-	NASA	1135	-	-	-	-	-
12	1960-09E Iota 5	-	NASA	1536	-	-	-	-	-
12	1965-04A	Tiros 5	NASA	708	Cyl	0.56 x 1.07	138	0.06516	0.04342
12	1960-09B Iota 2	Echo 1 Rocket	NASA	1503	Cyl	1.2 x 0.51	23	0.2661	0.03883
12	1965-98A	Alouette 2	CANADA	506	Oblate Sph	0.86 x 1.07	145	0.062	0.0498
12	1965-89A Geos 1	Explorer 29	NASA	1119	Octa + Pyra	0.81 x 1.22	175	0.04624	-
12	1965-63A	Secor 5 Rocket	USA	1127	Cyl	1.49 x 0.50	24	0.1201	0.08181
12	1965-63B	Secor 5	USA	1128	Sph	0.61	18	0.1624	-
11	1959-01B Alpha 2	Vanguard 2 Rocket	NASA	554	Cyl	1.2 x 0.51	23	0.2661	0.08883
11	1959-07A Eta 1	Vanguard 3	NASA	514	Octa	2.5 x 0.51	68	0.1875	0.03003
11	1963-25B	Hitch-Hiker 1	USA F	342	Octa	0.3 x 0.9	798.8+23	0.06189	0.02626
10	1966-52B	OV3-4 Rocket	USA F	644	Cyl	1.5 x 0.46	24	0.2865	0.06925
10	1966-52A	OV3-4	USA F	644	Cyl	0.7 x 0.7	78.5	0.0642	0.04902
9	1966-00C	-		667	-	-	-	-	-
9	1962-29A E PS 1	Telstar 1	AT/T	940	Sph	0.86	77	0.07545	-
9	1966-00B	-		724	-	-	-	-	-
9	1961-18A Sibma 1	Midas 3	USA F	3346	Cyl	9 x 1.5	1600	0.08438	0.01105
9	1966-00A	-		214	-	-	-	-	-
8	1966-56A	Pageos 1	-	2114	Infl. Sph.	30.48	55	132.68	-
8	1966-56B	Pageos 1 Rocket	-	4123	Cyl	6 x 1.5	700	0.1286	0.02525
8	1962-68B B UPS 2	Relay 1 Rocket	USN	1331	Cyl	1.8 x 0.46	23	0.360	0.07227
8	1962-68A B UPS 1	Relay 1	NASA	1367	Octa-Prism	0.81 x 0.74	78	0.0785	0.05515
7	1968-26B	OV1-14	-	560	-	-	-	-	-
6	1963-13A	Telstar 2	AT/T	980	Spheroid	0.94 x 0.86	79.4	0.07997	0.07317
4	1963-31B	Syncom 2 Rocket	-	345	Cyl	1.5 x 0.46	24	0.2875	0.0692
3	1966-110B	ATS 1 Rocket	-	168	Cyl	6 x 1.5	700	0.1286	0.025
2	1966-96A	Intelsat 2 F-1	CSC	3196	Cyl	0.5 x 1.42	140	0.1131	0.05075
2	1966-92A	Molniya 4	USSR	269	Windmill	3 x 1.5	1000	0.045	0.01767
2	1967-101A	Molniya 7	USSR	527	-	-	-	-	-
2	1964-49E	-		1531	-	-	-	-	-
2	1965-30A	Molniya 1	USSR	2021	Windmill	-	-	0.12	-
2	1967-82A	Cosmos 174	USSR	323	-	-	-	-	-
2	1964-49D	Cosmos 41	USSR	1415	-	-	-	-	-
2	1967-52A	Molniya 5	USSR	902	-	-	-	-	-
2	1966-35A	Molniya 3	USSR	1236	Cyl	3 x 1.5	-	-	-
1	1964-06D	Elektron 2 Rocket	-	3849	Cyl	10 x 2	1500	0.1333	0.02094
1	1966-53H	IDCSP 7	USA F	33630	Polyhedron (26 faces)	0.8 x 0.9	45	0.1266	-



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Table 2
Tables of Resonant Orbits

SATELLITE 68 015B

S = 15 REV./DAY PERIGEE HEIGHT = 267. KM.

A = 1.0824 E.R. E = 0.0375 I = 70.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,15, 6, -2	-48.8	7.62D-03	9.19D 02	8.17D-01
15,15, 7, 0	-93.5	8.10D-01	9.75D 04	4.56D 01
15,15, 8, 2	-1078.1	2.18D 00	2.62D 05	1.07D 01
16,15, 6, -3	-39.4	6.60D-04	7.96D 01	8.72D-02
16,15, 7, -1	-64.2	4.25D-01	5.13D 04	3.48D 01
16,15, 8, 1	-172.0	3.66D 00	4.41D 05	1.13D 02
16,15, 9, 3	252.6	6.66D-02	8.02D 03	1.40D 00
17,15, 7, -2	-48.8	4.98D-03	6.00D 02	5.33D-01
17,15, 8, 0	-93.5	2.39D 00	2.88D 05	1.34D 02
17,15, 9, 2	-1078.1	2.29D 01	2.76D 06	1.13D 02
17,15,10, 4	113.1	1.31D-03	1.57D 02	6.18D-02
18,15, 7, -3	-39.4	1.19D-03	1.43D 02	1.57D-01
18,15, 8, -1	-64.2	2.42D-01	2.91D 04	1.97D 01
18,15, 9, 1	-172.0	1.10D 00	1.32D 05	3.37D 01
18,15,10, 3	252.6	1.24D-01	1.50D 04	2.62D 00
19,15, 8, -2	-48.8	1.18D-02	1.42D 03	1.26D 00
19,15, 9, 0	-93.5	2.26D 00	2.72D 05	1.27D 02
19,15,10, 2	-1078.1	1.04D 00	1.26D 05	5.13D 00
19,15,11, 4	113.1	1.77D-03	2.13D 02	8.38D-02
20,15, 8, -3	-39.4	1.51D-03	1.82D 02	1.99D-01
20,15,10, 1	-172.0	2.58D 00	3.10D 05	7.90D 01
20,15,11, 3	252.6	4.84D-02	5.83D 03	1.02D 00

SATELLITE 68 006A

S = 15 REV./DAY PERIGEE HEIGHT = 516. KM.

A = 1.0822 E.R. E = 0.0012 I = 74.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,15, 7, 0	113.4	1.33D 00	1.60D 05	6.25D 01
16,15, 7, -1	432.4	4.99D-01	6.01D 04	6.14D 00
16,15, 8, 1	65.2	1.72D-02	2.07D 03	1.42D 00
17,15, 8, 0	113.4	1.54D 00	1.85D 05	7.24D 01
18,15, 8, -1	432.4	4.37D-01	5.26D 04	5.37D 00
18,15, 9, 1	65.2	2.32D-03	2.79D 02	1.91D-01
19,15, 9, 0	113.4	2.73D 00	3.29D 05	1.29D 02
20,15, 9, -1	432.4	2.57D-01	3.09D 04	3.16D 00
20,15,10, 1	65.2	6.95D-03	8.37D 02	5.73D-01

SATELLITE 68 006C

S = 15 REV./DAY PERIGEE HEIGHT = 503. KM.

A = 1.0839 E.R. E = 0.0047 I = 74.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,15, 7, 0	-38.0	1.49D-01	1.80D 04	2.05D 01
16,15, 7, -1	-30.5	9.71D-03	1.17D 03	1.65D 00
16,15, 8, 1	-50.4	4.02D-02	4.85D 03	4.18D 00
17,15, 8, 0	-38.0	1.72D-01	2.08D 04	2.36D 01
17,15, 9, 2	-74.9	1.54D-03	1.85D 02	1.08D-01
18,15, 8, -1	-30.5	8.50D-03	1.03D 03	1.44D 00
18,15, 9, 1	-50.4	5.41D-03	6.53D 02	5.62D-01
19,15, 9, 0	-38.0	3.06D-01	3.69D 04	4.19D 01
19,15,10, 2	-74.9	8.29D-04	1.00D 02	5.83D-02
20,15, 9, -1	-30.5	4.99D-03	6.02D 02	8.46D-01
20,15,10, 1	-50.4	1.62D-02	1.96D 03	1.68D 00

SATELLITE UK 3

S = 15 REV./DAY PERIGEE HEIGHT = 475. KM.

A = 1.0819 E.R. E = 0.0068 I = 80.16 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,15, 7, 0	21.9	6.28D-02	7.56D 03	1.57D 01
16,15, 7, -1	27.2	3.89D-03	4.69D 02	7.80D-01
16,15, 8, 1	18.3	6.73D-03	8.11D 02	2.04D 00
17,15, 7, -2	36.0	4.17D-04	5.03D 01	6.29D-02
17,15, 8, 0	21.9	7.61D-02	9.17D 03	1.92D 01
18,15, 8, -1	27.2	5.49D-03	6.61D 02	1.10D 00
18,15, 9, 1	18.3	5.25D-03	6.32D 02	1.60D 00
19,15, 9, 0	21.9	1.28D-02	1.55D 03	3.24D 00
20,15, 9, -1	27.2	6.38D-03	7.69D 02	1.29D 00
20,15,10, 1	18.3	3.07D-03	3.70D 02	9.39D-01

SATÉLLITE 68 028B

S = 14 REV./DAY PERIGEE HEIGHT = 139. KM.

A = 1.1353 E.R. E = 0.1000 I = 81.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 5, -3	-62.2	1.32D-02	1.66D 03	1.25D 00
14,14, 6, -1	-5049.0	2.69D 03	3.40D 08	3.18D 03
14,14, 7, 1	63.7	4.82D-01	6.09D 04	4.58D 01
14,14, 8, 3	31.7	5.07D-03	6.41D 02	9.80D-01
15,14, 5, -4	-41.6	5.20D-04	6.57D 01	7.34D-02
15,14, 6, -2	-122.8	7.27D-02	9.19D 03	3.52D 00
15,14, 7, 0	129.1	1.23D 00	1.56D 05	5.74D 01
15,14, 8, 2	42.3	5.31D-02	6.71D 03	7.64D 00
15,14, 9, 4	25.3	5.92D-04	7.48D 01	1.44D-01
16,14, 6, -3	-62.2	1.59D-02	2.01D 03	1.51D 00
16,14, 7, -1	-5049.0	3.14D 03	3.97D 08	3.72D 03
16,14, 8, 1	63.7	1.34D-01	1.70D 04	1.28D 01
16,14, 9, 3	31.7	1.12D-02	1.42D 03	2.17D 00
17,14, 6, -4	-41.6	1.63D-03	2.06D 02	2.30D-01
17,14, 7, -2	-122.8	1.50D-01	1.90D 04	7.26D 00
17,14, 8, 0	129.1	3.00D 00	3.79D 05	1.40D 02
17,14, 9, 2	42.3	7.80D-02	9.86D 03	1.13D 01
17,14,10, 4	25.3	5.17D-04	6.53D 01	1.26D-01
18,14, 7, -3	-62.2	1.54D-02	1.94D 03	1.46D 00
18,14, 8, -1	-5049.0	2.40D 03	3.03D 08	2.84D 03
18,14, 9, 1	63.7	1.72D-01	2.17D 04	1.64D 01
18,14,10, 3	31.7	1.43D-02	1.81D 03	2.78D 00
19,14, 7, -4	-41.6	2.05D-03	2.59D 02	7.88D-01
19,14, 8, -2	-122.8	9.36D-02	1.18D 04	4.52D 00
19,14, 9, 0	129.1	2.72D 00	3.44D 05	1.27D 02
19,14,10, 2	42.3	2.36D-02	2.98D 03	3.41D 00
19,14,11, 4	25.3	1.75D-03	2.21D 02	4.30D-01
20,14, 8, -3	-62.2	1.75D-02	2.21D 03	1.66D 00
20,14, 9, -1	-5049.0	1.77D 03	2.23D 08	2.09D 03
20,14,10, 1	63.7	3.18D-01	4.02D 04	3.04D 01
20,14,11, 3	31.7	1.00D-02	1.27D 03	1.96D 00

SATELLITE 62 25C

S = 14 REV./DAY PERIGEE HEIGHT = 600. KM.

A = 1.1312 E.R. E = 0.0328 I = 58.20 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 5, -3	103.0	7.61D-04	9.58D 01	4.41D-02
14,14, 6, -1	368.6	1.11D 00	1.40D 05	1.79D 01
14,14, 7, 1	-233.5	2.16D-01	2.72D 04	5.46D 00
15,14, 6, -2	161.0	3.76D-02	4.74D 03	1.39D 00
15,14, 7, 0	-1273.3	7.68D 01	9.67D 06	3.57D 02
15,14, 8, 2	-128.5	9.75D-03	1.23D 03	4.47D-01
16,14, 6, -3	103.0	1.92D-03	2.41D 02	1.11D-01
16,14, 7, -1	368.6	5.14D 00	6.47D 05	8.27D 01
16,14, 8, 1	-233.5	1.79D 00	2.25D 05	4.52D 01
16,14, 9, 3	-88.7	1.20D-03	1.51D 02	7.93D-02
17,14, 7, -2	161.0	5.27D-02	6.63D 03	1.95D 00
17,14, 8, 0	-1273.3	2.57D 02	3.24D 07	1.20D 03
17,14, 9, 2	-128.5	7.81D-02	9.84D 03	3.58D 00
18,14, 7, -3	103.0	1.90D-03	2.39D 02	1.10D-01
18,14, 8, -1	368.6	1.45D 00	1.83D 05	2.34D 01
18,14, 9, 1	-233.5	2.18D 00	2.75D 05	5.52D 01
18,14,10, 3	-88.7	3.61D-03	4.54D 02	2.39D-01
19,14, 8, -2	161.0	7.24D-02	9.12D 03	2.68D 00
19,14, 9, 0	-1273.3	3.08D 01	3.87D 06	1.43D 02
19,14,10, 2	-128.5	8.85D-02	1.11D 04	4.05D 00
20,14, 8, -3	103.0	6.39D-04	8.04D 01	3.71D-02
20,14, 9, -1	368.6	3.01D 00	3.79D 05	4.85D 01
20,14,10, 1	-233.5	5.47D-02	6.89D 03	1.38D 00
20,14,11, 3	-88.7	3.96D-03	4.99D 02	2.62D-01

SATELLITE 63 26A

S = 14 REV./DAY PERIGEE HEIGHT = 412. KM.

A = 1.1294 E.R. E = 0.0574 I = 49.70 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 6, -1	63.7	2.00D-02	2.51D 03	1.87D 00
14,14, 7, 1	-239.6	9.57D-02	1.20D 04	2.35D 00
15,14, 6, -2	39.0	3.78D-03	4.75D 02	5.83D-01
15,14, 7, 0	173.7	5.52D-01	6.94D 04	1.38D 01
15,14, 8, 2	-70.9	2.18D-03	2.74D 02	1.80D-01
16,14, 6, -3	28.1	1.02D-03	1.29D 02	2.21D-01
16,14, 7, -1	63.7	1.75D-01	2.20D 04	1.64D 01
16,14, 8, 1	-239.6	1.27D 00	1.60D 05	3.12D 01
17,14, 7, -2	39.0	1.94D-02	2.44D 03	2.99D 00
17,14, 8, 0	173.7	3.78D 00	4.75D 05	1.29D 02
17,14, 9, 2	-70.9	2.88D-02	3.62D 03	2.37D 00
18,14, 7, -3	28.1	7.47D-04	9.39D 01	1.62D-01
18,14, 8, -1	63.7	2.69D-01	3.38D 04	2.63D 01
18,14, 9, 1	-239.6	3.34D 00	4.19D 05	8.19D 01
18,14,10, 3	-41.6	1.72D-03	2.16D 02	2.38D-01
19,14, 8, -2	39.0	1.02D-02	1.28D 03	1.53D 00
19,14, 9, 0	173.7	4.62D 00	5.81D 05	1.58D 02
19,14,10, 2	-70.9	7.37D-02	9.26D 03	6.05D 00
20,14, 8, -3	28.1	8.46D-04	1.06D 02	1.84D-01
20,14, 9, -1	63.7	1.14D-01	1.43D 04	1.07D 01
20,14,10, 1	-239.6	4.14D 00	5.20D 05	1.02D 02
20,14,11, 3	-41.6	4.47D-03	5.63D 02	6.20D-01

SATELLITE 62 02B

S = 14 REV./DAY PERIGEE HEIGHT = 700. KM.

A = 1.1285 E.R. E = 0.0166 I = 48.10 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 6, -1	33.4	1.12D-03	1.40D 02	2.01D-01
14,14, 7, 1	131.0	5.41D-03	6.80D 02	2.45D-01
15,14, 7, 0	53.2	3.35D-02	4.21D 03	3.76D 00
15,14, 8, 2	-284.4	1.93D-03	2.43D 02	3.99D-02
16,14, 7, -1	33.4	1.04D-02	1.31D 03	1.88D 00
16,14, 8, 1	131.0	7.52D-02	9.45D 03	3.41D 00
17,14, 7, -2	24.3	5.49D-04	6.89D 01	1.38D-01
17,14, 8, 0	53.2	2.41D-01	3.02D 04	2.71D 01
17,14, 9, 2	-284.4	2.69D-02	3.38D 03	5.55D-01
18,14, 8, -1	33.4	1.81D-02	2.27D 03	3.27D 00
18,14, 9, 1	131.0	2.12D-01	2.66D 04	9.59D 00
19,14, 8, -2	24.3	4.21D-04	5.29D 01	1.06D-01
19,14, 9, 0	53.2	3.27D-01	4.11D 04	3.68D 01
19,14,10, 2	-284.4	7.46D-02	9.37D 03	1.54D 00
20,14, 9, -1	33.4	1.15D-02	1.44D 03	2.08D 00
20,14,10, 1	131.0	2.99D-01	3.76D 04	1.36D 01

SATELLITE 63 43A

S = 14 REV./DAY PERIGEE HEIGHT = 335. KM.

A = 1.1295 E.R. E = 0.0682 I = 58.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 5, -3	24.4	4.30D-04	5.41D 01	1.07D-01
14,14, 6, -1	28.8	1.67D-02	2.10D 03	3.51D 00
14,14, 7, 1	35.1	1.24D-02	1.56D 03	2.12D 00
15,14, 6, -2	26.4	4.93D-03	6.20D 02	1.13D 00
15,14, 7, 0	31.7	6.16D-02	7.75D 03	1.18D 01
15,14, 8, 2	39.5	4.75D-03	5.97D 02	7.25D-01
16,14, 6, -3	24.4	9.87D-04	1.24D 02	2.46D-01
16,14, 7, -1	28.8	7.54D-02	9.48D 03	1.59D 01
16,14, 8, 1	35.1	1.01D-01	1.27D 04	1.74D 01
16,14, 9, 3	45.0	3.28D-03	4.13D 02	4.39D-01
17,14, 7, -2	26.4	5.89D-03	7.40D 02	1.36D 00
17,14, 8, 0	31.7	2.03D-01	2.55D 04	3.89D 01
17,14, 9, 2	39.5	3.73D-02	4.69D 03	5.70D 00
17,14,10, 4	52.3	7.21D-04	9.07D 01	8.27D-02
18,14, 7, -3	24.4	1.15D-03	1.45D 02	2.89D-01
18,14, 8, -1	28.8	1.55D-02	1.95D 03	3.28D 00
18,14, 9, 1	35.1	1.18D-01	1.49D 04	2.04D 01
18,14,10, 3	45.0	9.63D-03	1.21D 03	1.29D 00
19,14, 8, -2	26.4	1.01D-02	1.27D 03	2.34D 00
19,14, 9, 0	31.7	8.73D-02	1.10D 03	1.68D 00
19,14,10, 2	39.5	3.96D-02	4.98D 03	6.07D 00
19,14,11, 4	52.3	2.00D-03	2.51D 02	2.29D-01
20,14, 9, -1	28.8	4.75D-02	5.97D 03	1.01D 01
20,14,10, 1	35.1	8.85D-03	1.11D 03	1.53D 00
20,14,11, 3	45.0	9.76D-02	1.23D 03	1.31D 00

SATELLITE 60 07A

S = 14 REV./DAY PERIGEE HEIGHT = 615. KM.

A = 1.1307 E.R. E = 0.0303 I = 66.70 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 6, -1	27.9	1.22D-02	1.53D 03	2.65D 00
14,14, 7, 1	25.1	6.66D-03	8.38D 02	1.61D 00
15,14, 6, -2	29.5	1.14D-03	1.43D 02	2.34D-01
15,14, 7, 0	26.5	5.76D-02	7.24D 03	1.33D 01
15,14, 8, 2	24.0	7.63D-04	9.60D 01	1.95D-01
16,14, 7, -1	27.9	1.79D-02	2.26D 03	3.92D 00
16,14, 8, 1	25.1	2.77D-02	3.49D 03	6.75D 00
17,14, 7, -2	29.5	1.68D-03	2.12D 02	3.47D-01
17,14, 8, 0	26.5	3.50D-02	4.41D 03	8.10D 00
17,14, 9, 2	24.0	2.77D-03	3.49D 02	7.10D-01
18,14, 8, -1	27.9	1.77D-02	2.23D 03	3.89D 00
18,14, 9, 1	25.1	5.29D-04	6.66D 01	1.29D-01
19,14, 9, 0	26.5	6.41D-02	8.07D 03	1.49D 01
19,14,10, 2	24.0	5.95D-04	7.48D 01	1.53D-01
20,14, 9, -1	27.9	4.34D-03	5.47D 02	9.55D-01
20,14,10, 1	25.1	1.43D-02	1.79D 03	3.49D 00

SATELLITE 66 25D

S = 14 REV./DAY PERIGEE HEIGHT = 886. KM.

A = 1.1487 E.R. E = 0.0085 I = 144.50 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
16,14, 8, 1	-213.4	3.45D-03	4.42D 02	9.93D-02
17,14, 8, 0	66.6	3.95D-03	5.05D 02	3.70D-01
18,14, 9, 1	-213.4	1.61D-02	2.06D 03	4.64D-01
19,14, 9, 0	66.6	1.47D-02	1.88D 03	1.38D 00
20,14,10, 1	-213.4	4.63D-02	5.91D 03	1.33D 00

SATELLITE 60 09A

S = 14 REV./DAY PERIGEE HEIGHT = 730. KM.

A = 1.1321 E.R. E = 0.0156 I = 47.20 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 6, -1	-26.4	5.55D-04	7.00D 01	1.22D-01
15,14, 7, 0	-20.2	4.06D-03	5.12D 02	1.15D 00
16,14, 7, -1	-26.4	5.44D-03	6.85D 02	1.19D 00
16,14, 8, 1	-16.3	9.24D-04	1.16D 02	3.21D-01
17,14, 7, -2	-38.2	1.14D-03	1.44D 02	1.73D-01
17,14, 8, 0	-20.2	3.06D-02	3.86D 03	8.66D 00
18,14, 8, -1	-26.4	1.01D-02	1.28D 03	2.21D 00
18,14, 9, 1	-16.3	2.73D-03	3.44D 02	9.44D-01
19,14, 8, -2	-38.2	1.03D-03	1.30D 02	1.57D-01
19,14, 9, 0	-20.2	4.49D-02	5.66D 03	1.26D 01
20,14, 9, -1	-26.4	7.66D-03	9.65D 02	1.66D 00
20,14,10, 1	-16.3	4.18D-03	5.26D 02	1.43D 00

SATELLITE 59 09A

S = 14 REV./DAY PERIGEE HEIGHT = 551. KM.

A = 1.1265 E.R. E = 0.0356 I = 50.30 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 6, -1	14.1	6.28D-04	7.88D 01	2.76D-01
14,14, 7, 1	19.2	4.08D-04	5.12D 01	1.29D-01
15,14, 7, 0	16.2	4.75D-03	5.96D 02	1.80D 00
16,14, 7, -1	14.1	5.22D-03	6.55D 02	2.31D 00
16,14, 8, 1	19.2	5.19D-03	6.51D 02	1.65D 00
17,14, 7, -2	12.4	7.15D-04	8.96D 01	3.62D-01
17,14, 8, 0	16.2	3.04D-02	3.81D 03	1.16D 01
17,14, 9, 2	23.5	1.26D-03	1.58D 02	3.27D-01
18,14, 8, -1	14.1	7.42D-03	9.30D 02	3.30D 00
18,14, 9, 1	19.2	1.29D-02	1.61D 03	4.12D 00
19,14, 9, 0	16.2	3.37D-02	4.23D 03	1.29D 01
19,14,10, 2	23.5	3.06D-03	3.84D 02	7.95D-01
20,14, 9, -1	14.1	2.42D-03	3.03D 02	1.08D 00
20,14,10, 1	19.2	1.46D-02	1.83D 03	4.70D 00
20,14,11, 3	30.3	9.50D-04	7.02D 01	1.12D-01

SATELLITE 66 25A

S = 14 REV./DAY PERIGEE HEIGHT = 887. KM.

A = 1.1488 E.R. E = 0.0085 I = 144.50 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
16,14, 8, 1	-152.7	1.77D-03	2.26D 02	7.09D-02
17,14, 8, 0	76.0	5.15D-03	6.59D 02	4.22D-01
18,14, 9, 1	-152.7	8.26D-03	1.06D 03	3.31D-01
19,14, 9, 0	76.0	1.92D-02	2.46D 03	1.58D 00
20,14,10, 1	-152.7	2.37D-02	3.03D 03	9.48D-01

SATELLITE 63 54C

S = 14 REV./DAY PERIGEE HEIGHT = 697. KM.

A = 1.1265 E.R. E = 0.0153 I = 58.40 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 6, -1	11.1	4.68D-04	5.87D 01	2.65D-01
15,14, 7, 0	11.5	6.13D-03	7.69D 02	3.34D 00
16,14, 7, -1	11.1	2.11D-03	2.65D 02	1.21D 00
16,14, 8, 1	12.0	2.17D-03	2.72D 02	1.14D 00
17,14, 8, 0	11.5	1.98D-02	2.48D 03	1.09D 01
18,14, 8, -1	11.1	5.35D-04	6.71D 01	3.08D-01
18,14, 9, 1	12.0	2.57D-03	3.22D 02	1.36D 00
19,14, 9, 0	11.5	1.82D-03	2.28D 02	1.01D 00
20,14, 9, -1	11.1	1.22D-03	1.53D 02	7.11D-01

SATELLITE 64 26A

S = 14 REV./DAY PERIGEE HEIGHT = 854. KM.

A = 1.1415 E.R. E = 0.0066 I = 90.50 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 6, -1	-13.4	7.72D-04	9.81D 01	3.31D-01
14,14, 7, 1	-17.6	2.06D-03	2.62D 02	6.84D-01
15,14, 7, 0	-15.2	8.12D-03	1.03D 03	3.08D 00
16,14, 8, 1	-17.6	2.19D-03	2.78D 02	7.23D-01
17,14, 8, 0	-15.2	1.61D-02	2.05D 03	6.07D 00
18,14, 9, 1	-17.6	1.61D-03	2.04D 02	5.27D-01
19,14, 9, 0	-15.2	1.26D-02	1.61D 03	4.73D 00
20,14,10, 1	-17.6	1.23D-03	1.56D 02	4.01D-01

SATELLITE 66 31B

S = 14 REV./DAY PERIGEE HEIGHT = 787. KM.

A = 1.1246 E.R. E = 0.0011 I = 35.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
17,14, 8, 0	16.9	1.96D-03	2.45D 02	7.14D-01
19,14, 9, 0	16.9	5.67D-03	7.10D 02	2.08D 00

SATELLITE 65 81A

S = 14 REV./DAY PERIGEE HEIGHT = 419. KM.

A = 1.1463 E.R. E = 0.0703 I = 87.30 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14,14, 6, -1	-5.7	1.87D-03	2.39D 02	1.79D 00
14,14, 7, 1	-6.3	3.23D-03	4.12D 02	2.81D 00
15,14, 7, 0	-6.0	4.46D-04	5.69D 01	4.04D-01
16,14, 7, -1	-5.7	1.75D-03	2.23D 02	1.64D 00
16,14, 8, 1	-6.3	3.32D-03	4.24D 02	2.85D 00
17,14, 7, -2	-5.4	4.08D-04	5.20D 01	3.96D-01
17,14, 8, 0	-6.0	7.78D-04	9.93D 01	6.95D-01
17,14, 9, 2	-6.7	9.05D-04	1.15D 02	7.35D-01
18,14, 8, -1	-5.7	1.19D-03	1.52D 02	1.10D 00
18,14, 9, 1	-6.3	2.34D-03	2.99D 02	1.99D 00
19,14, 9, 0	-6.0	5.00D-04	6.38D 01	4.41D-01
9,14,10, 2	-6.7	8.55D-04	1.09D 02	6.86D-01
20,14, 9, -1	-5.7	8.93D-04	1.14D 02	8.15D-01
20,14,10, 1	-6.3	1.70D-03	2.17D 02	1.43D 00

SATELLITE 64 31A

S = 14 REV./DAY PERIGEE HEIGHT = 828. KM.

A = 1.1306 E.R. E = 0.0007 I = 99.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,14, 7, 0	5.6	2.34D-03	2.94D 02	2.85D 00
17,14, 8, 0	5.6	2.17D-03	2.74D 02	2.70D 00

SATELLITE 64 51B

S = 14 REV./DAY PERIGEE HEIGHT = 867. KM.

A = 1.1474 E.R. E = 0.0100 I = 79.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,14, 7, 0	-4.6	1.06D-03	1.35D 02	1.21D 00
17,14, 8, 0	-4.6	2.12D-03	2.71D 02	2.37D 00
19,14, 9, 0	-4.6	1.54D-03	1.97D 02	1.69D 00

SATELLITE 64 01A

S = 14 REV./DAY PERIGEE HEIGHT = 910. KM.

A = 1.1446 E.R. E = 0.0017 I = 69.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,14, 7, 0	-4.9	1.94D-03	2.47D 02	2.09D 00
17,14, 8, 0	-4.9	4.31D-04	5.49D 01	4.56D-01
19,14, 9, 0	-4.9	1.35D-03	1.72D 02	1.41D 00

SATELLITE 64 51A

S = 14 REV./DAY PERIGEE HEIGHT = 867. KM.

A = 1.1480 E.R. E = 0.0105 I = 79.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,14, 7, 0	-4.4	9.60D-04	1.23D 02	1.14D 00
17,14, 8, 0	-4.4	1.92D-03	2.45D 02	2.24D 00
19,14, 9, 0	-4.4	1.39D-03	1.78D 02	1.60D 00

SATELLITE 65 16A

S = 14 REV./DAY PERIGEE HEIGHT = 907. KM.

A = 1.1449 E.R. E = 0.0024 I = 70.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,14, 7, 0	-4.8	1.85D-03	2.35D 02	2.03D 00
17,14, 8, 0	-4.8	4.54D-04	5.79D 01	4.91D-01
19,14, 9, 0	-4.8	1.26D-03	1.60D 02	1.34D 00

SATELLITE 61 15A

S = 14 REV./DAY PERIGEE HEIGHT = 883. KM.

A = 1.1471 E.R. E = 0.0076 I = 66.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15.14, 7, 0	-3.9	1.11D-03	1.42D 02	1.47D 00
17.14, 8, 0	-3.9	6.33D-04	8.08D 01	8.24D-01
19.14, 9, 0	-3.9	1.18D-03	1.51D 02	1.51D 00

SATELLITE 64 76A

S = 14 REV./DAY PERIGEE HEIGHT = 505. KM.

A = 1.1530 E.R. E = 0.0640 I = 81.30 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
14.14, 6, -1	-3.1	5.31D-04	6.81D 01	8.54D-01
14.14, 7, 1	-3.3	6.66D-04	8.55D 01	1.03D 00
15.14, 7, 0	-3.2	5.03D-04	6.45D 01	7.84D-01
16.14, 7, -1	-3.1	5.95D-04	7.64D 01	9.34D-01
17.14, 8, 0	-3.2	1.15D-03	1.47D 02	1.75D 00
18.14, 8, -1	-3.1	4.38D-04	5.63D 01	6.72D-01
19.14, 9, 0	-3.2	9.81D-04	1.26D 02	1.46D 00

SATELLITE 61 15B

S = 14 REV./DAY PERIGEE HEIGHT = 884. KM.

A = 1.1473 E.R. E = 0.0076 I = 66.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15.14, 7, 0	-3.8	1.08D-03	1.38D 02	1.45D 00
17.14, 8, 0	-3.8	6.15D-04	7.86D 01	8.10D-01
19.14, 9, 0	-3.8	1.15D-03	1.47D 02	1.48D 00

SATELLITE 64 64A

S = 14 REV./DAY PERIGEE HEIGHT = 887. KM.

A = 1.1541 E.R. E = 0.0130 I = 79.60 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15.14, 7, 0	-3.0	4.44D-04	5.70D 01	7.39D-01
17.14, 8, 0	-3.0	9.69D-04	1.12D 02	1.41D 00
19.14, 9, 0	-3.0	6.14D-04	7.88D 01	9.72D-01

SATELLITE 58 01A**S = 14 REV./DAY PERIGEE HEIGHT = 339. KM.****A = 1.1194 E.R. E = 0.0592 I = 33.10 DEG.**

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
19,14, 9, 0	6.6	7.51D-04	9.36D 01	7.59D-01
20,14, 9, -1	5.7	6.97D-04	8.68D 01	8.43D-01
20,14,10, 1	7.9	4.43D-04	5.52D 01	3.71D-01

SATELLITE 67 11A**S = 14 REV./DAY PERIGEE HEIGHT = 566. KM.****A = 1.1492 E.R. E = 0.0526 I = 39.90 DEG.**

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
19,14, 9, 0	-2.7	4.31D-04	5.51D 01	7.30D-01

SATELLITE 68 011B**S = 13 REV./DAY PERIGEE HEIGHT = 1185. KM.****A = 1.1875 E.R. E = 0.0014 I = 74.00 DEG.**

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 6, 0	12.6	1.62D-02	2.15D 03	9.10D 00
15,13, 7, 0	12.6	1.85D-03	2.44D 02	1.05D 00
17,13, 8, 0	12.6	5.23D-03	6.91D 02	2.98D 00
19,13, 9, 0	12.6	4.02D-03	5.31D 02	2.31D 00

SATELLITE 65 27A

S = 13 REV./DAY PERIGEE HEIGHT = 271. KM.

A = 1.2033 E.R. E = 0.1337 I = 90.20 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 5, -2	-7.1	1.29D-03	1.73D 02	1.15D 00
13,13, 6, 0	-7.9	1.52D-02	2.04D 03	1.22D 01
13,13, 7, 2	-9.0	5.50D-03	7.37D 02	3.92D 00
14,13, 6, -1	-7.5	2.68D-03	3.59D 02	2.25D 00
14,13, 8, 3	-9.6	6.47D-04	8.67D 01	4.31D-01
15,13, 7, 0	-7.9	6.61D-03	8.85D 02	5.23D 00
15,13, 8, 2	-9.0	2.93D-03	3.93D 02	2.07D 00
16,13, 7, -1	-7.5	4.22D-03	5.65D 02	3.50D 00
16,13, 9, 3	-9.6	1.24D-03	1.67D 02	8.19D-01
17,13, 7, -2	-7.1	8.04D-04	1.08D 02	6.95D-01
17,13, 8, 0	-7.9	4.92D-03	6.59D 02	3.85D 00
17,13, 9, 2	-9.0	2.59D-03	3.47D 02	1.81D 00
18,13, 8, -1	-7.5	3.51D-03	4.70D 02	2.87D 00
18,13,10, 3	-9.6	1.23D-03	1.65D 02	8.04D-01
19,13, 8, -2	-7.1	1.01D-03	1.36D 02	8.65D-01
19,13, 9, 0	-7.9	3.38D-03	4.53D 02	2.61D 00
19,13,10, 2	-9.0	2.07D-03	2.77D 02	1.43D 00
20,13, 9, -1	-7.5	2.86D-03	3.84D 02	2.32D 00
20,13,11, 3	-9.6	1.17D-03	1.57D 02	7.58D-01

SATELLITE 65 27C

S = 13 REV./DAY PERIGEE HEIGHT = 1240. KM.

A = 1.2026 E.R. E = 0.0068 I = 90.20 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 6, 0	-8.7	9.04D-03	1.21D 03	6.63D 00
15,13, 7, 0	-8.7	3.22D-03	4.32D 02	2.34D 00
17,13, 8, 0	-8.7	1.95D-03	2.61D 02	1.40D 00
19,13, 9, 0	-8.7	1.07D-03	1.44D 02	7.63D-01

SATELLITE 67 14A

S = 13 REV./DAY PERIGEE HEIGHT = 587. KM.

A = 1.1929 E.R. E = 0.0846 I = 39.40 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,13, 6, -2	-15.6	7.58D-04	1.01D 02	3.13D-01
15,13, 7, 0	-10.6	9.73D-04	1.29D 02	5.76D-01
16,13, 6, -3	-20.4	5.76D-04	7.65D 01	1.84D-01
16,13, 7, -1	-12.6	2.49D-03	3.31D 02	1.25D 00
16,13, 8, 1	-9.2	4.65D-04	6.17D 01	3.14D-01
17,13, 7, -2	-15.6	2.14D-03	2.84D 02	8.78D-01
17,13, 8, 0	-10.6	3.29D-03	4.37D 02	1.93D 00
18,13, 7, -3	-20.4	8.37D-04	1.11D 02	2.65D-01
18,13, 8, -1	-12.6	4.84D-03	6.43D 02	2.41D 00
18,13, 9, 1	-9.2	1.32D-03	1.75D 02	8.83D-01
19,13, 8, -2	-15.6	2.67D-03	3.55D 02	1.09D 00
19,13, 9, 0	-10.6	5.64D-03	7.48D 02	3.28D 00
20,13, 8, -3	-20.4	4.17D-04	5.53D 01	1.32D-01
20,13, 9, -1	-12.6	5.48D-03	7.28D 02	2.71D 00
20,13,10, 1	-9.2	2.38D-03	3.16D 02	1.57D 00

SATELLITE 68 002B

S = 13 REV./DAY PERIGEE HEIGHT = 1083. KM.

A = 1.2081 E.R. E = 0.0317 I = 105.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 6, 0	-6.6	2.39D-03	3.21D 02	2.28D 00
14,13, 7, 1	-6.8	5.47D-04	7.36D 01	5.04D-01
15,13, 7, 0	-6.6	2.35D-03	3.16D 02	2.21D 00
17,13, 8, 0	-6.6	1.26D-03	1.70D 02	1.17D 00

SATELLITE GEOS II

S = 13 REV./DAY PERIGEE HEIGHT = 1084. KM.

A = 1.2086 E.R. E = 0.0320 I = 105.81 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 6, 0	-6.3	2.16D-03	2.91D 02	2.15D 00
14,13, 7, 1	-6.5	4.97D-04	6.69D 01	4.80D-01
15,13, 7, 0	-6.3	2.13D-03	2.86D 02	2.09D 00
17,13, 8, 0	-6.3	1.14D-03	1.54D 02	1.11D 00

SATELLITE 60 14A

S = 13 REV./DAY PERIGEE HEIGHT = 416. KM.

A = 1.2045 E.R. E = 0.1156 I = 49.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,13, 7, 0	-3.9	9.25D-04	1.24D 02	1.37D 00
16,13, 7, -1	-4.0	1.15D-03	1.55D 02	1.65D 00
16,13, 8, 1	-3.7	7.43D-04	9.96D 01	1.12D 00
17,13, 8, 0	-3.9	1.77D-03	2.38D 02	2.57D 00
18,13, 8, -1	-4.0	7.86D-04	1.05D 02	1.10D 00
18,13, 9, 1	-3.7	1.16D-03	1.55D 02	1.70D 00
19,13, 9, 0	-3.9	1.06D-03	1.42D 02	1.51D 00
19,13,10, 2	-3.6	4.73D-04	6.34D 01	7.03D-01
20,13,10, 1	-3.7	7.16D-04	9.59D 01	1.03D 00

SATELLITE 62 60A

S = 13 REV./DAY PERIGEE HEIGHT = 1075. KM.

A = 1.1770 E.R. E = 0.0072 I = 50.10 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
15,13, 7, 0	5.3	9.44D-04	1.24D 02	1.37D 00
17,13, 8, 0	5.3	1.51D-03	1.98D 02	2.24D 00
19,13, 9, 0	5.3	7.27D-04	9.53D 01	1.11D 00

SATELLITE 63 53A

S = 13 REV./DAY PERIGEE HEIGHT = 767. KM.

A = 1.2152 E.R. E = 0.0781 I = 78.70 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 6, 0	-2.8	1.17D-03	1.58D 02	2.32D 00

SATELLITE 65 32A

S = 13 REV./DAY PERIGEE HEIGHT = 941. KM.

A = 1.1764 E.P. E = 0.0246 I = 41.10 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
17,13, 8, 0	5.6	7.70D-04	1.01D 02	1.08D 00
19,13, 9, 0	5.6	1.07D-03	1.40D 02	1.54D 00

SATELLITE 63 38C**S = 13 REV./DAY PERIGEE HEIGHT = 1104. KM.****A = 1.1731 E.R. E = 0.0 I = 89.90 DEG.**

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 6, 0	2.7	8.72D-04	1.14D 02	2.86D 00

SATELLITE 63 49B**S = 13 REV./DAY PERIGEE HEIGHT = 1051. KM.****A = 1.1715 E.R. E = 0.0057 I = 89.90 DEG.**

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 6, 0	2.5	7.55D-04	9.84D 01	2.72D 00

SATELLITE 65 48A**S = 13 REV./DAY PERIGEE HEIGHT = 1028. KM.****A = 1.1700 E.R. E = 0.0075 I = 89.90 DEG.**

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,13, 6, 0	2.3	6.65D-04	8.65D 01	2.60D 00

SATELLITE 61 048

S = 12 REV./DAY PERIGEE HEIGHT = 633. KM.

A = 1.2528 E.R. E = 0.1226 I = 38.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
12,12, 6, 1	-467.8	9.69D-03	1.35D 03	1.58D-01
13,12, 5, -2	26.7	1.38D-03	1.92D 02	4.07D-01
13,12, 6, 0	90.4	2.74D-02	3.82D 03	2.34D 00
13,12, 7, 2	-65.2	5.46D-04	7.62D 01	6.33D-02
14,12, 5, -3	19.7	4.40D-04	6.14D 01	1.78D-01
14,12, 6, -1	41.2	1.28D-02	1.79D 02	2.43D 00
14,12, 7, 1	-467.8	5.05D-01	7.05D 04	8.25D 00
15,12, 6, -2	26.7	6.56D-03	9.14D 02	1.94D 00
15,12, 7, 0	90.4	1.55D-01	2.16D 04	1.32D 01
15,12, 8, 2	-65.2	5.49D-03	7.65D 02	6.35D-01
16,12, 6, -3	19.7	9.39D-04	1.31D 02	3.82D-01
16,12, 7, -1	41.2	3.48D-02	4.85D 03	6.60D 00
16,12, 8, 1	-467.8	2.01D 00	2.80D 05	3.28D 01
17,12, 7, -2	26.7	7.50D-03	1.05D 03	2.23D 00
17,12, 8, 0	90.4	2.38D-01	3.32D 04	2.04D 01
17,12, 9, 2	-65.2	1.46D-02	2.03D 03	1.68D 00
18,12, 7, -3	19.7	6.65D-04	9.28D 01	2.72D-01
18,12, 8, -1	41.2	4.49D-02	6.27D 03	8.55D 00
18,12, 9, 1	-467.8	4.06D 00	5.66D 05	6.62D 01
18,12,10, 3	-35.0	1.13D-03	1.57D 02	2.38D-01
19,12, 8, -2	26.7	5.21D-03	7.26D 02	1.56D 00
19,12, 9, 0	90.4	2.93D-01	4.09D 04	2.51D 01
19,12,10, 2	-65.2	3.14D-02	4.38D 03	3.62D 00
20,12, 9, -1	41.2	3.16D-02	4.41D 03	6.03D 00
20,12,10, 1	-467.8	5.36D 00	7.47D 05	8.74D 01
20,12,11, 3	-35.0	2.65D-03	3.69D 02	5.59D-01

SATELLITE 66 13A

S = 12 REV./DAY PERIGEE HEIGHT = 508. KM.

A = 1.2529 E.R. E = 0.1383 I = 34.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,12, 5, -2	28.9	9.48D-04	1.32D 02	2.58D-01
13,12, 6, 0	362.3	1.62D-01	2.25D 04	3.42D 00
14,12, 5, -3	19.8	3.84D-04	5.35D 01	1.55D-01
14,12, 6, -1	53.5	1.09D-02	1.53D 03	1.59D 00
14,12, 7, 1	-76.0	4.94D-03	6.90D 02	4.92D-01
15,12, 6, -2	28.9	5.74D-03	8.00D 02	1.57D 00
15,12, 7, 0	362.3	1.12D 00	1.56D 05	2.37D 01
15,12, 8, 2	-34.4	5.81D-04	8.11D 01	1.26D-01
16,12, 6, -3	19.8	1.16D-03	1.62D 02	4.71D-01
16,12, 7, -1	53.5	3.80D-02	5.30D 03	5.52D 00
16,12, 8, 1	-76.0	2.39D-02	3.33D 03	2.38D 00
17,12, 7, -2	28.9	9.28D-03	1.29D 03	2.54D 00
17,12, 8, 0	362.3	2.22D 00	3.10D 05	4.70D 01
17,12, 9, 2	-34.4	1.86D-03	2.60D 02	4.03D-01
18,12, 7, -3	19.8	1.62D-03	2.26D 02	6.61D-01
18,12, 8, -1	53.5	6.91D-02	9.63D 03	1.01D 01
18,12, 9, 1	-76.0	6.15D-02	8.58D 03	6.11D 00
19,12, 8, -2	28.9	1.18D-02	1.65D 03	3.26D 00
19,12, 9, 0	362.3	3.83D 00	5.34D 05	8.11D 01
19,12,10, 2	-34.4	5.09D-03	7.10D 02	1.10D 00
20,12, 8, -3	19.8	1.13D-03	1.58D 02	4.63D-01
20,12, 9, -1	53.5	8.46D-02	1.18D 04	1.23D 01
20,12,10, 1	-76.0	1.12D-01	1.56D 04	1.11D 01
20,12,11, 3	-22.2	6.34D-04	8.84D 01	2.07D-01

SATELLITE 66 138

S = 12 REV./DAY PERIGEE HEIGHT = 500. KM.

A = 1.2527 E.R. E = 0.1392 I = 34.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A' (METERS)
13,12, 5, -2	26.7	8.25D-04	1.15D 02	2.43D-01
13,12, 6, 0	180.3	4.04D-02	5.63D 03	1.72D 00
14,12, 6, -1	46.6	8.38D-03	1.17D 03	1.40D 00
14,12, 7, 1	-96.3	8.04D-03	1.12D 03	6.33D-01
15,12, 6, -2	26.7	5.00D-03	6.98D 02	1.48D 00
15,12, 7, 0	180.3	2.80D-01	3.91D 04	1.19D 01
15,12, 8, 2	-38.0	7.23D-04	1.01D 02	1.42D-01
16,12, 6, -3	18.7	1.07D-03	1.49D 02	4.59D-01
16,12, 7, -1	46.6	2.92D-02	4.07D 03	4.89D 00
16,12, 8, 1	-96.3	3.89D-02	5.43D 03	3.06D 00
17,12, 7, -2	26.7	8.10D-03	1.13D 03	2.41D 00
17,12, 8, 0	180.3	5.57D-01	7.77D 04	2.38D 01
17,12, 9, 2	-38.0	2.32D-03	3.24D 02	4.56D-01
18,12, 7, -3	18.7	1.49D-03	2.08D 02	6.44D-01
18,12, 8, -1	46.6	5.31D-02	7.41D 03	8.92D 00
18,12, 9, 1	-96.3	1.00D-01	1.40D 04	7.89D 00
19,12, 8, -2	26.7	1.04D-02	1.44D 03	3.09D 00
19,12, 9, 0	180.3	9.64D-01	1.34D 05	4.11D 01
19,12,10, 2	-38.0	6.35D-03	8.86D 02	1.24D 00
20,12, 8, -3	18.7	1.04D-03	1.45D 02	4.53D-01
20,12, 9, -1	46.6	6.52D-02	9.09D 03	1.10D 01
20,12,10, 1	-96.3	1.83D-01	2.55D 04	1.44D 01
20,12,11, 3	-23.7	7.39D-04	1.03D 02	2.28D-01

SATELLITE 65 89C

S = 12 REV./DAY PERIGEE HEIGHT = 1135. KM.

A = 1.2578 E.R. E = 0.0635 I = 59.30 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
12,12, 5, -1	-43.8	2.70D-03	3.78D 02	4.69D-01
12,12, 6, 1	-37.6	1.09D-03	1.52D 02	2.20D-01
13,12, 5, -2	-47.8	5.06D-03	7.08D 02	8.04D-01
13,12, 6, 0	-40.5	5.84D-02	8.17D 03	1.09D 01
13,12, 7, 2	-35.1	1.60D-03	2.24D 02	3.45D-01
14,12, 6, -1	-43.8	2.44D-02	3.42D 03	4.23D 00
14,12, 7, 1	-37.6	2.06D-02	2.88D 03	4.14D 00
15,12, 7, 0	-40.5	6.89D-02	9.64D 03	1.29D 01
15,12, 8, 2	-35.1	5.62D-03	7.88D 02	1.21D 00
16,12, 6, -3	-52.6	5.35D-04	7.50D 01	7.73D-02
16,12, 7, -1	-43.8	4.68D-03	6.55D 02	8.07D-01
16,12, 8, 1	-37.6	1.57D-02	2.19D 03	3.14D 00
16,12, 9, 3	-32.9	5.53D-04	7.74D 01	1.26D-01
17,12, 7, -2	-47.8	3.18D-03	4.45D 02	5.03D-01
17,12, 8, 0	-40.5	1.43D-02	2.01D 03	2.67D 00
17,12, 9, 2	-35.1	2.59D-03	3.62D 02	5.54D-01
18,12, 8, -1	-43.8	1.02D-02	1.43D 03	1.76D 00
18,12, 9, 1	-37.6	6.61D-03	9.25D 02	1.32D 00
19,12, 8, -2	-47.8	1.94D-03	2.71D 02	3.06D-01
19,12, 9, 0	-40.5	1.53D-02	2.14D 03	2.84D 00
19,12,10, 2	-35.1	1.56D-03	2.18D 02	3.33D-01
20,12, 9, -1	-43.8	6.53D-03	9.14D 02	1.12D 00
20,12,10, 1	-37.6	5.56D-03	7.79D 02	1.11D 00

SATELLITE 60 09E

S = 12 REV./DAY PERIGEE HEIGHT = 1536. KM.

A = 1.2524 E.R. E = 0.0093 I = 47.20 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,12, 6, 0	31.3	8.16D-03	1.14D 03	2.04D 00
14,12, 6, -1	24.9	6.77D-04	9.43D 01	2.15D-01
14,12, 7, 1	42.2	9.90D-04	1.38D 02	1.83D-01
15,12, 7, 0	31.3	2.62D-02	3.65D 03	6.57D 00
16,12, 7, -1	24.9	9.10D-04	1.27D 02	2.90D-01
16,12, 8, 1	42.2	2.35D-03	3.28D 02	4.36D-01
17,12, 8, 0	31.3	1.85D-02	2.58D 03	4.67D 00
18,12, 9, 1	42.2	2.32D-03	3.23D 02	4.30D-01
19,12, 9, 0	31.3	5.36D-03	7.47D 02	1.35D 00
20,12,10, 1	42.2	8.20D-04	1.14D 02	1.53D-01

SATELLITE 65 04A

S = 12 REV./DAY PERIGEE HEIGHT = 708. KM.

A = 1.2577 E.R. E = 0.1167 I = 96.40 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
12,12, 5, -1	17.0	1.27D-03	1.78D 02	6.05D-01
12,12, 6, 1	14.1	1.84D-03	2.58D 02	1.06D 00
13,12, 5, -2	18.9	2.79D-03	3.90D 02	1.19D 00
13,12, 6, 0	15.4	1.45D-02	2.03D 03	7.66D 00
13,12, 7, 2	13.0	5.44D-04	7.61D 01	3.43D-01
14,12, 5, -3	21.3	5.94D-04	8.31D 01	2.24D-01
14,12, 6, -1	17.0	3.50D-03	4.89D 02	1.67D 00
14,12, 7, 1	14.1	4.05D-03	5.66D 02	2.35D 00
14,12, 8, 3	12.1	4.09D-04	5.73D 01	2.81D-01
15,12, 7, 0	15.4	1.34D-02	1.88D 03	7.13D 00
15,12, 8, 2	13.0	1.07D-03	1.50D 02	6.80D-01
16,12, 7, -1	17.0	5.45D-03	7.62D 02	2.62D 00
16,12, 8, 1	14.1	1.55D-03	2.17D 02	9.08D-01
16,12, 9, 3	12.1	4.09D-04	5.73D 01	2.84D-01
17,12, 7, -2	18.9	1.30D-03	1.82D 02	5.61D-01
17,12, 8, 0	15.4	5.48D-03	7.67D 02	2.93D 00
17,12, 9, ?	13.0	9.03D-04	1.26D 02	5.80D-01
18,12, 8, -1	17.0	4.22D-03	5.91D 02	2.05D 00
18,12,10, .	12.1	3.58D-04	5.01D 01	2.51D-01
19,12, 8, -2	18.9	1.63D-03	2.29D 02	7.09D-01
19,12, 9, 0	15.4	2.37D-03	3.31D 02	1.28D 00
19,12,10, 2	13.0	8.85D-04	1.24D 02	5.74D-01
20,12, 8, -3	21.3	4.02D-04	5.63D 01	1.54D-01
20,12, 9, -1	17.0	2.62D-03	3.67D 02	1.28D 00
20,12,10, 1	14.1	7.36D-04	1.03D 02	4.39D-01

SATELLITE 60 09B

S = 12 REV./DAY PERIGEE HEIGHT = 1503. KM.

A = 1.2498 E.R. E = 0.0113 I = 47.20 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,12, 6, 0	14.5	1.75D-03	2.43D 02	9.70D-01
15,12, 7, 0	14.5	5.61D-03	7.80D 02	3.14D 00
16,12, 8, 1	16.4	4.35D-04	6.05D 01	2.13D-01
17,12, 8, 0	14.5	3.97D-03	5.52D 02	2.24D 00
18,12, 9, 1	16.4	4.28D-04	5.96D 01	2.12D-01
19,12, 9, 0	14.5	1.15D-03	1.60D 02	6.53D-01

SATELLITE 65 98A

S = 12 REV./DAY PERIGEE HEIGHT = 506. KM.

A = 1.2720 E.R. E = 0.1515 I = 79.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
12,12, 6, 1	-5.7	4.22D-04	5.98D 01	5.24D-01
13,12, 6, 0	-5.5	1.65D-03	2.34D 02	2.09D 00
13,12, 7, 2	-5.9	1.09D-03	1.55D 02	1.31D 00
14,12, 6, -1	-5.4	1.15D-03	1.63D 02	1.48D 00
15,12, 7, 0	-5.5	2.33D-03	3.30D 02	2.89D 00
15,12, 8, 2	-5.9	8.02D-04	1.14D 02	9.45D-01
16,12, 7, -1	-5.4	9.11D-04	1.29D 02	1.15D 00
16,12, 8, 1	-5.7	6.49D-04	9.18D 01	7.77D-01
17,12, 8, 0	-5.5	1.46D-03	2.07D 02	1.78D 00
18,12, 8, -1	-5.4	5.78D-04	8.19D 01	7.15D-01
18,12, 9, 1	-5.7	9.18D-04	1.30D 02	1.08D 00
19,12, 9, 0	-5.5	1.06D-03	1.50D 02	1.27D 00
20,12,10, 1	-5.7	8.69D-04	1.23D 02	1.01D 00

SATELLITE 65 89A

S = 12 REV./DAY PERIGEE HEIGHT = 1119. KM.

A = 1.2658 E.R. E = 0.0714 I = 59.30 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,12, 6, 0	-7.3	1.93D-03	2.72D 02	1.88D 00
14,12, 6, -1	-7.4	7.85D-04	1.11D 02	7.51D-01
14,12, 7, 1	-7.2	8.52D-04	1.20D 02	8.35D-01
15,12, 7, 0	-7.3	2.30D-03	3.25D 02	2.22D 00
16,12, 8, 1	-7.2	6.53D-04	9.20D 01	6.31D-01
17,12, 8, 0	-7.3	4.86D-04	6.85D 01	4.61D-01
19,12, 9, 0	-7.3	5.25D-04	7.39D 01	4.91D-01

SATELLITE 65 63A

S = 12 REV./DAY PERIGEE HEIGHT = 1127. KM.

A = 1.2791 E.R. E = 0.0800 I = 69.20 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,12, 6, 0	-3.3	5.78D-04	8.23D 01	1.13D 00

SATELLITE 59 01B

S = 11 REV./DAY PERIGEE HEIGHT = 554. KM.

A = 1.3291 E.R. E = 0.1823 I = 32.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
11,11, 4, -2	32.9	9.71D-04	1.44D 02	2.67D-01
11,11, 5, 0	362.1	9.65D-02	1.43D 04	2.37D 00
12,11, 5, -1	60.4	5.31D-03	7.86D 02	7.90D-01
12,11, 6, 1	-90.5	2.25D-03	3.32D 02	2.18D-01
13,11, 5, -2	32.9	1.03D-03	1.53D 02	2.86D-01
13,11, 6, 0	362.1	1.16D-01	1.72D 04	2.85D 00
14,11, 5, -3	22.6	7.10D-04	1.05D 02	2.90D-01
14,11, 6, -1	60.4	1.63D-02	2.41D 03	2.43D 00
14,11, 7, 1	-90.5	9.70D-03	1.43D 03	9.41D-01
15,11, 6, -2	32.9	1.29D-03	1.91D 02	3.57D-01
15,11, 7, 0	362.1	1.77D-01	2.61D 04	4.34D 00
16,11, 6, -3	22.6	2.05D-03	3.04D 02	8.42D-01
16,11, 7, -1	60.4	5.92D-02	8.76D 03	8.84D 00
16,11, 8, 1	-90.5	5.02D-02	7.42D 03	4.86D 00
17,11, 7, -2	32.9	1.31D-02	1.94D 03	3.64D 00
17,11, 8, 0	362.1	2.39D 00	3.54D 05	5.88D 01
17,11, 9, 2	-40.2	4.26D-03	6.30D 02	9.14D-01
18,11, 7, -3	22.6	1.77D-03	2.63D 02	7.32D-01
18,11, 8, -1	60.4	8.07D-02	1.19D 04	1.21D 01
18,11, 9, 1	-90.5	1.01D-01	1.49D 04	9.73D 00
18,11,10, 3	-25.9	5.66D-04	8.37D 01	1.86D-01
19,11, 8, -2	32.9	1.16D-02	1.71D 03	3.23D 00
19,11, 9, 0	362.1	3.28D 00	4.85D 05	8.05D 01
19,11,10, 2	-40.2	9.22D-03	1.36D 03	1.97D 00
20,11, 9, -1	60.4	7.41D-02	1.10D 04	1.11D 01
20,11,10, 1	-90.5	1.48D-01	2.18D 04	1.43D 01
20,11,11, 3	-25.9	1.35D-03	1.99D 02	4.40D-01

SATELLITE 65 63B

S = 12 REV./DAY PERIGEE HEIGHT = 1128. KM.

A = 1.2792 E.R. E = 0.0800 I = 69.20 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13,12, 6, 0	-3.3	5.72D-04	8.15D 01	1.13D 00

SATELLITE 59 07A

S = 11 REV./DAY PERIGEE HEIGHT = 514. KM.

A = 1.3300 E.R. E = 0.1875 I = 33.30 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
11,11, 4, -2	52.7	2.93D-03	4.34D 02	5.01D-01
11,11, 5, 0	-120.0	1.23D-02	1.83D 03	9.08D-01
12,11, 4, -3	30.6	5.59D-04	8.27D 01	1.66D-01
12,11, 5, -1	187.9	6.00D-02	8.88D 03	2.85D 00
12,11, 6, 1	-45.5	6.78D-04	1.00D 02	1.30D-01
13,11, 5, -2	52.7	3.10D-03	4.59D 02	5.31D-01
13,11, 6, 0	-120.0	1.49D-02	2.20D 03	1.09D 00
14,11, 5, -3	30.6	1.53D-03	2.26D 02	4.56D-01
14,11, 6, -1	187.9	1.83D-01	2.71D 04	8.71D 00
14,11, 7, 1	-45.5	2.93D-03	4.34D 02	5.61D-01
15,11, 6, -2	52.7	3.83D-03	5.67D 02	6.57D-01
15,11, 7, 0	-120.0	2.26D-02	3.35D 03	1.66D 00
16,11, 6, -3	30.6	4.31D-03	6.39D 02	1.29D 00
16,11, 7, -1	187.9	6.62D-01	9.80D 04	3.15D 01
16,11, 8, 1	-45.5	1.51D-02	2.24D 03	2.89D 00
17,11, 6, -4	21.6	3.41D-04	5.05D 01	1.48D-01
17,11, 7, -2	52.7	3.82D-02	5.65D 03	6.57D 00
17,11, 8, 0	-120.0	3.05D-01	4.52D 04	2.24D 01
17,11, 9, 2	-28.1	2.55D-03	3.77D 02	7.77D-01
18,11, 7, -3	30.6	3.53D-03	5.23D 02	1.06D 00
18,11, 8, -1	187.9	8.90D-01	1.32D 05	4.23D 01
18,11, 9, 1	-45.5	3.01D-02	4.46D 03	5.74D 00
18,11,10, 3	-20.3	4.43D-04	6.56D 01	1.84D-01
19,11, 8, -2	52.7	3.24D-02	4.79D 03	5.58D 00
19,11, 9, 0	-120.0	4.13D-01	6.12D 04	3.03D 01
19,11,10, 2	-28.1	5.48D-03	8.12D 02	1.66D 00
20,11, 9, -1	187.9	7.92D-01	1.17D 05	3.77D 01
20,11,10, 1	-45.5	4.37D-02	6.48D 03	8.31D 00
20,11,11, 3	-20.3	1.05D-03	1.55D 02	4.31D-01

SATELLITE 63 25B

S = 11 REV./DAY PERIGEE HEIGHT = 342. KM.

A = 1.3396 E.R. E = 0.2135 I = 82.10 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
11.11, 4, -2	-15.1	9.31D-03	1.39D 03	5.33D 00
11.11, 5, 0	-17.7	7.37D-02	1.10D 04	3.62D 01
11.11, 6, 2	-21.5	3.46D-02	5.16D 03	1.41D 01
11.11, 7, 4	-27.2	2.15D-03	3.20D 02	6.95D-01
12.11, 4, -3	-14.0	7.03D-04	1.05D 02	4.29D-01
12.11, 5, -1	-16.3	2.04D-03	3.04D 02	1.08D 00
12.11, 6, 1	-19.4	1.74D-02	2.59D 03	7.78D 00
12.11, 7, 3	-24.0	6.98D-03	1.04D 03	2.55D 00
12.11, 8, 5	-31.5	3.84D-04	5.72D 01	1.08D-01
13.11, 5, -2	-15.1	9.11D-04	1.36D 02	5.18D-01
13.11, 6, 0	-17.7	6.34D-03	9.45D 02	3.09D 00
13.11, 7, 2	-21.5	5.92D-04	8.83D 01	2.40D-01
13.11, 8, 4	-27.2	8.55D-04	1.27D 02	2.75D-01
14.11, 5, -3	-14.0	6.12D-04	9.12D 01	3.71D-01
14.11, 6, -1	-16.3	8.06D-04	1.20D 02	4.24D-01
14.11, 7, 1	-19.4	1.23D-02	1.84D 03	5.49D 00
14.11, 8, 3	-24.0	2.10D-03	3.14D 02	7.64D-01
14.11, 9, 5	-31.5	3.82D-04	5.70D 01	1.07D-01
15.11, 6, -2	-15.1	3.71D-04	5.53D 01	2.09D-01
15.11, 7, 0	-17.7	1.88D-03	2.80D 02	9.10D-01
15.11, 8, 2	-21.5	1.32D-03	1.96D 02	5.30D-01
15.11, 9, 4	-27.2	3.65D-04	5.44D 01	1.17D-01
16.11, 6, -3	-14.0	1.09D-03	1.62D 02	6.52D-01
16.11, 8, 1	-19.4	1.67D-02	2.49D 03	7.38D 00
16.11, 9, 3	-24.0	1.40D-03	2.08D 02	5.04D-01
16.11, 10, 5	-31.5	1.06D-03	1.58D 02	2.94D-01
17.11, 7, -2	-15.1	2.41D-03	3.59D 02	1.35D 00
17.11, 8, 0	-17.7	7.35D-03	1.10D 03	3.54D 00
17.11, 9, 2	-21.5	1.08D-02	1.61D 03	4.33D 00
17.11, 10, 4	-27.2	7.44D-04	1.11D 02	2.37D-01
17.11, 11, 6	-37.3	3.45D-04	5.14D 01	8.13D-02
18.11, 7, -3	-14.0	1.08D-03	1.61D 02	6.43D-01
18.11, 8, -1	-16.3	1.30D-03	1.94D 02	6.76D-01
18.11, 9, 1	-19.4	1.17D-02	1.74D 03	5.13D 00
18.11, 10, 3	-24.0	4.37D-03	6.52D 02	1.57D 00
18.11, 11, 5	-31.5	7.01D-04	1.05D 02	1.94D-01
19.11, 8, -2	-15.1	2.35D-03	3.50D 02	1.30D 00
19.11, 9, 0	-17.7	3.30D-03	4.92D 02	1.58D 00
19.11, 10, 2	-21.5	9.69D-03	1.45D 03	3.87D 00
19.11, 11, 4	-27.2	1.07D-03	1.59D 02	3.39D-01
19.11, 12, 6	-37.3	3.56D-04	5.31D 01	8.36D-02
20.11, 8, -3	-14.0	1.06D-03	1.58D 02	6.25D-01
20.11, 9, -1	-16.3	2.20D-03	3.28D 02	1.13D 00
20.11, 10, 1	-19.4	7.24D-03	1.08D 03	3.17D 00
20.11, 11, 3	-24.0	5.44D-03	8.12D 02	1.95D 00

SATELLITE 66 52B

S = 10 REV./DAY PERIGEE HEIGHT = 644. KM.

A = 1.4207 E.R. E = 0.2251 I = 40.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
10,10, 3, -3	700.4	2.32D-01	3.67D 04	3.47D 00
10,10, 4, -1	-65.2	8.93D-03	1.41D 03	1.42D 00
10,10, 5, 1	-31.2	5.40D-04	8.54D 01	1.77D-01
11,10, 3, -4	102.0	1.70D-03	2.69D 02	1.76D-01
11,10, 4, -2	-143.9	4.93D-02	7.79D 03	3.57D 00
11,10, 5, 0	-42.2	5.86D-03	9.27D 02	1.43D 00
12,10, 4, -3	700.4	2.01D-01	3.18D 04	3.01D 00
12,10, 5, -1	-65.2	9.42D-03	1.49D 03	1.49D 00
12,10, 6, 1	-31.2	8.83D-04	1.40D 02	2.89D-01
13,10, 4, -4	102.0	2.40D-03	3.79D 02	2.49D-01
13,10, 5, -2	-143.9	1.30D-01	2.06D 04	9.40D 00
13,10, 6, 0	-42.2	2.16D-02	3.42D 03	5.25D 00
13,10, 7, 2	-24.7	1.11D-03	1.75D 02	4.52D-01
14,10, 5, -3	700.4	6.31D-01	9.98D 04	9.45D 00
14,10, 6, -1	-65.2	5.69D-02	9.00D 03	9.00D 00
14,10, 7, 1	-31.2	8.86D-03	1.40D 03	2.89D 00
15,10, 5, -4	102.0	1.13D-03	1.79D 02	1.18D-01
15,10, 6, -2	-143.9	4.49D-02	7.11D 03	3.25D 00
15,10, 7, 0	-42.2	1.48D-02	2.34D 03	3.58D 00
15,10, 8, 2	-24.7	1.41D-03	2.23D 02	5.72D-01
16,10, 6, -3	700.4	5.83D-01	9.22D 04	8.74D 00
16,10, 7, -1	-65.2	6.72D-02	1.06D 04	1.06D 01
16,10, 8, 1	-31.2	2.18D-02	3.45D 03	7.08D 00
16,10, 9, 3	-20.5	1.30D-03	2.05D 02	6.28D-01
17,10, 6, -4	102.0	6.53D-03	1.03D 03	6.79D-01
17,10, 7, -2	-143.9	3.82D-02	6.04D 03	2.76D 00
17,10, 8, 0	-42.2	3.68D-02	5.81D 03	8.88D 00
17,10, 9, 2	-24.7	7.52D-03	1.19D 03	3.04D 00
18,10, 7, -3	700.4	1.18D 00	1.87D 05	1.78D 01
18,10, 8, -1	-65.2	2.79D-03	4.42D 02	4.40D-01
18,10, 9, 1	-31.2	1.74D-02	2.76D 03	5.63D 00
18,10,10, 3	-20.5	2.19D-03	3.47D 02	1.06D 00
19,10, 7, -4	102.0	2.52D-03	3.99D 02	2.62D-01
19,10, 8, -2	-143.9	1.20D-01	1.90D 04	8.68D 00
19,10, 9, 0	-42.2	4.22D-03	6.67D 02	1.02D 00
19,10,10, 2	-24.7	6.91D-03	1.09D 03	2.78D 00
19,10,11, 4	-17.5	5.58D-04	8.83D 01	3.11D-01
20,10, 7, -5	55.0	4.63D-04	7.32D 01	9.04D-02
20,10, 8, -3	700.4	2.01D-02	3.18D 03	3.01D-01
20,10, 9, -1	-65.2	3.82D-02	6.04D 03	6.00D 00
20,10,10, 1	-31.2	4.45D-03	7.04D 02	1.43D 00
20,10,11, 3	-20.5	2.33D-03	3.69D 02	1.12D 00
20,20, 6, -6	350.2	7.40D-04	1.17D 02	2.22D-02

SATELLITE 66 52A

S = 10 REV./DAY PERIGEE HEIGHT = 644. KM.

A = 1.4211 E.R. E = 0.2253 I = 40.80 DEG.

L, M, P, G	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
10,10, 3, -3	-358.1	6.08D-02	9.62D 03	1.78D 00
10,10, 4, -1	-51.2	5.51D-03	8.71D 02	1.11D 00
10,10, 5, 1	-27.6	4.23D-04	6.69D 01	1.57D-01
11,10, 3, -4	179.3	5.27D-03	8.34D 02	3.10D-01
11,10, 4, -2	-89.6	1.91D-02	3.03D 03	2.22D 00
11,10, 5, 0	-35.8	4.23D-03	6.70D 02	1.21D 00
12,10, 4, -3	-358.1	5.27D-02	8.33D 03	1.54D 00
12,10, 5, -1	-51.2	5.81D-03	9.19D 02	1.17D 00
12,10, 6, 1	-27.6	6.92D-04	1.10D 02	2.55D-01
13,10, 4, -4	179.3	7.45D-03	1.18D 03	4.38D-01
13,10, 5, -2	-89.6	5.05D-02	7.99D 03	5.85D 00
13,10, 6, 0	-35.8	1.56D-02	2.47D 03	4.46D 00
13,10, 7, 2	-22.4	9.12D-04	1.44D 02	4.10D-01
14,10, 5, -3	-358.1	1.66D-01	2.62D 04	4.83D 00
14,10, 6, -1	-51.2	3.51D-02	5.56D 03	7.06D 00
14,10, 7, 1	-27.6	6.95D-03	1.10D 03	2.55D 00
15,10, 5, -4	179.3	3.51D-03	5.56D 02	2.07D-01
15,10, 6, -2	-89.6	1.75D-02	2.76D 03	2.02D 00
15,10, 7, 0	-35.8	1.07D-02	1.69D 03	3.04D 00
15,10, 8, 2	-22.4	1.16D-03	1.84D 02	5.19D-01
16,10, 5, -5	71.7	5.09D-04	8.05D 01	7.56D-02
16,10, 6, -3	-358.1	1.53D-01	2.42D 04	4.47D 00
16,10, 7, -1	-51.2	4.15D-02	6.56D 03	8.31D 00
16,10, 8, 1	-27.6	1.71D-02	2.71D 03	6.25D 00
16,10, 9, 3	-18.9	1.10D-03	1.75D 02	5.79D-01
17,10, 6, -4	179.3	2.03D-02	3.21D 03	1.19D 00
17,10, 7, -2	-89.6	1.49D-02	2.35D 03	1.72D 00
17,10, 8, 0	-35.8	2.66D-02	4.21D 03	7.53D 00
17,10, 9, 2	-22.4	6.20D-03	9.81D 02	2.75D 00
18,10, 6, -5	71.7	5.21D-04	8.25D 01	7.76D-02
18,10, 7, -3	-358.1	3.11D-01	4.92D 04	9.07D 00
18,10, 8, -1	-51.2	1.73D-03	2.73D 02	3.45D-01
18,10, 9, 1	-27.6	1.37D-02	2.16D 03	4.97D 00
18,10,10, 3	-18.9	1.87D-03	2.96D 02	9.74D-01
19,10, 7, -4	179.3	7.84D-03	1.24D 03	4.62D-01
19,10, 8, -2	-89.6	4.68D-02	7.40D 03	5.40D 00
19,10, 9, 0	-35.8	3.06D-03	4.83D 02	8.62D-01
19,10,10, 2	-22.4	5.70D-03	9.01D 02	2.52D 00
19,10,11, 4	-16.3	4.87D-04	7.71D 01	2.90D-01
20,10, 7, -5	71.7	7.91D-04	1.25D 02	1.18D-01
20,10, 8, -3	-358.1	5.27D-03	8.34D 02	1.54D-01
20,10, 9, -1	-51.2	2.36D-02	3.73D 03	4.71D 00
20,10,10, 1	-27.6	3.50D-03	5.53D 02	1.27D 00
20,10,11, 3	-18.9	1.99D-03	3.15D 02	1.03D 00

SATELLITE 66 00C

S = 9 REV./DAY PERIGEE HEIGHT = 667. KM.

A = 1.5408 E.R. E = 0.2831 I = 84.60 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
9, 9, 3, -2	-7.8	6.99D-04	1.20D 02	1.05D 00
9, 9, 4, 0	-8.3	5.73D-03	9.82D 02	8.17D 00
9, 9, 5, 2	-8.7	2.57D-03	4.41D 02	3.47D 00
10, 9, 4, -1	-8.0	8.15D-04	1.40D 02	1.18D 00
10, 9, 5, 1	-8.5	1.27D-03	2.17D 02	1.74D 00
10, 9, 6, 3	-9.0	6.46D-04	1.11D 02	8.42D-01
11, 9, 5, 0	-8.3	9.77D-04	1.68D 02	1.37D 00
12, 9, 6, 1	-8.5	3.80D-04	6.52D 01	5.15D-01
13, 9, 6, 0	-8.3	1.04D-03	1.78D 02	1.43D 00
14, 9, 6, -1	-8.0	6.24D-04	1.07D 02	8.75D-01
14, 9, 7, 1	-8.5	1.24D-03	2.12D 02	1.65D 00
15, 9, 7, 0	-8.3	5.60D-04	9.60D 01	7.60D-01
16, 9, 7, -1	-8.0	3.81D-04	6.54D 01	5.26D-01
16, 9, 8, 1	-8.5	8.42D-04	1.44D 02	1.11D 00
17, 9, 8, 0	-8.3	6.68D-04	1.15D 02	8.93D-01
17, 9, 9, 2	-8.7	4.39D-04	7.53D 01	5.58D-01
18, 9, 9, 1	-8.5	6.34D-04	1.09D 02	8.21D-01
19, 9, 9, 0	-8.3	4.52D-04	7.76D 01	5.95D-01
19, 9, 10, 2	-8.7	3.98D-04	6.83D 01	4.99D-01
20, 9, 10, 1	-8.5	4.64D-04	7.95D 01	5.91D-01
18,18, 8, 0	-4.1	5.21D-04	8.93D 01	1.38D 00
18,18, 9, 2	-4.2	4.68D-04	8.02D 01	1.21D 00

SATELLITE 62 29A

S = 9 REV./DAY PERIGEE HEIGHT = 940. KM.

A = 1.5164 E.R. E = 0.2434 I = 44.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
9, 9, 3, -2	13.9	6.53D-04	1.10D 02	6.10D-01
9, 9, 4, 0	16.5	1.66D-03	2.80D 02	1.30D 00
10, 9, 4, -1	15.1	1.99D-03	3.35D 02	1.71D 00
10, 9, 5, 1	18.1	1.29D-03	2.18D 02	9.22D-01
11, 9, 4, -2	13.9	5.00D-04	8.43D 01	4.72D-01
11, 9, 5, 0	16.5	1.81D-03	3.05D 02	1.43D 00
11, 9, 6, 2	20.1	4.01D-04	6.78D 01	2.57D-01
12, 9, 5, -1	15.1	9.06D-04	1.53D 02	7.90D-01
12, 9, 6, 1	18.1	1.09D-03	1.84D 02	7.81D-01
13, 9, 5, -2	13.9	3.25D-04	5.48D 01	3.10D-01
13, 9, 6, 0	16.5	3.40D-03	5.73D 02	2.71D 00
13, 9, 7, 2	20.1	1.63D-03	2.75D 02	1.05D 00
14, 9, 6, -1	15.1	1.33D-03	2.25D 02	1.18D 00
14, 9, 7, 1	18.1	4.93D-03	8.32D 02	3.57D 00
14, 9, 8, 3	22.6	1.20D-03	2.02D 02	6.87D-01
15, 9, 7, 0	16.5	1.08D-03	1.82D 02	8.69D-01
15, 9, 8, 2	20.1	1.60D-03	2.70D 02	1.04D 00
16, 9, 7, -1	15.1	8.69D-04	1.47D 02	7.74D-01
16, 9, 8, 1	18.1	2.02D-03	3.41D 02	1.48D 00
16, 9, 9, 3	22.6	1.44D-03	2.43D 02	8.31D-01
17, 9, 7, -2	13.9	3.29D-04	5.56D 01	3.22D-01
17, 9, 8, 0	16.5	9.32D-04	1.57D 02	7.58D-01
17, 9, 9, 2	20.1	1.59D-03	2.68D 02	1.04D 00
17, 9, 10, 4	25.9	6.32D-04	1.07D 02	3.17D-01
18, 9, 8, -1	15.1	7.43D-04	1.25D 02	6.68D-01
18, 9, 9, 1	18.1	6.14D-04	1.04D 02	4.53D-01
18, 9, 10, 3	22.6	9.92D-04	1.67D 02	5.75D-01
19, 9, 9, 0	16.5	1.09D-03	1.85D 02	6.00D-01
19, 9, 11, 4	25.9	5.24D-04	8.85D 01	2.65D-01
20, 9, 10, 1	18.1	1.12D-03	1.90D 02	8.36D-01

SATELLITE 66 008

S = 9 REV./DAY PERIGEE HEIGHT = 724. KM.

A = 1.5430 E.R. E = 0.2783 I = 84.60 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
9, 9, 3, -2	-6.8	4.95D-04	8.51D 01	8.44D-01
9, 9, 4, 0	-7.1	4.07D-03	7.00D 02	6.65D 00
9, 9, 5, 2	-7.5	1.76D-03	3.03D 02	2.75D 00
10, 9, 4, -1	-7.0	5.77D-04	9.90D 01	9.53D-01
10, 9, 5, 1	-7.3	8.82D-04	1.52D 02	1.40D 00
10, 9, 6, 3	-7.7	4.31D-04	7.40D 01	6.51D-01
11, 9, 5, 0	-7.1	6.85D-04	1.18D 02	1.10D 00
13, 9, 6, 0	-7.1	7.19D-04	1.23D 02	1.13D 00
14, 9, 6, -1	-7.0	4.30D-04	7.39D 01	6.84D-01
14, 9, 7, 1	-7.3	8.40D-04	1.44D 02	1.28D 00
15, 9, 7, 0	-7.1	3.82D-04	6.55D 01	5.89D-01
16, 9, 8, 1	-7.3	5.64D-04	9.68D 01	8.45D-01
17, 9, 8, 0	-7.1	4.49D-04	7.71D 01	6.81D-01
18, 9, 9, 1	-7.3	4.19D-04	7.19D 01	6.17D-01
19, 9, 9, 0	-7.1	2.99D-04	5.14D 01	4.47D-01
20, 9, 10, 1	-7.3	3.02D-04	5.18D 01	4.37D-01
18, 18, 8, 0	-3.6	3.48D-04	5.97D 01	1.05D 00
18, 18, 9, 2	-3.7	3.07D-04	5.27D 01	9.05D-01

SATELLITE 61 18A

S = 9 REV./DAY PERIGEE HEIGHT = 3346. KM.

A = 1.5401 E.R. E = 0.0101 I = 91.10 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
9, 9, 4, 0	-9.3	1.51D-03	2.58D 02	1.93D 00

SATELLITE 66 00A

S = 9 REV./DAY PERIGEE HEIGHT = 214. KM.

A = 1.4998 E.R. E = 0.3109 I = 35.10 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
13, 9, 6, 0	5.0	4.52D-04	7.55D 01	1.37D 00
14, 9, 6, -1	4.7	8.01D-04	1.34D 02	2.63D 00
14, 9, 7, 1	5.2	6.15D-04	1.03D 02	1.79D 00
15, 9, 7, 0	5.0	5.16D-04	8.61D 01	1.63D 00
16, 9, 7, -1	4.7	5.62D-04	9.39D 01	1.92D 00
16, 9, 8, 1	5.2	8.15D-04	1.36D 02	2.45D 00
17, 9, 8, 0	5.0	8.04D-04	1.34D 02	2.54D 00
17, 9, 9, 2	5.5	5.58D-04	9.31D 01	1.60D 00
18, 9, 9, 1	5.2	8.25D-04	1.38D 02	2.58D 00
18, 9, 10, 3	5.8	3.07D-04	5.13D 01	8.34D-01
19, 9, 9, 0	5.0	3.38D-04	5.64D 01	1.15D 00
19, 9, 10, 2	5.5	6.47D-04	1.08D 02	1.92D 00
20, 9, 10, 1	5.2	4.83D-04	8.06D 01	1.57D 00
20, 9, 11, 3	5.8	4.10D-04	6.84D 01	1.15D 00

SATELLITE 66 56A

S = 8 REV./DAY PERIGEE HEIGHT = 2114. KM.

A = 1.6542 E.R. E = 0.1951 I = 84.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
8, 8, 2, -3	-42.9	3.91D-04	7.20D 01	1.37D-01
8, 8, 3, -1	-54.4	5.12D-02	9.43D 03	1.42D 01
8, 8, 4, 1	-74.3	1.80D-01	3.31D 04	3.67D 01
8, 8, 5, 3	-117.3	2.29D-02	4.22D 03	2.97D 00
8, 8, 6, 5	-278.7	6.40D-04	1.18D 02	3.51D-02
9, 8, 3, -2	-47.9	4.61D-03	8.49D 02	1.45D 00
9, 8, 4, 0	-62.8	8.56D-03	1.58D 03	2.06D 00
9, 8, 5, 2	-91.0	4.07D-02	7.49D 03	6.79D 00
9, 8, 6, 4	-165.2	6.08D-03	1.12D 03	5.62D-01
9, 8, 7, 6	-891.9	7.51D-04	1.38D 02	1.29D-02
10, 8, 4, -1	-54.4	5.48D-03	1.01D 03	1.52D 00
10, 8, 5, 1	-74.3	1.89D-02	3.48D 03	3.85D 00
10, 8, 6, 3	-117.3	2.82D-03	5.19D 02	3.65D-01
10, 8, 7, 5	-278.7	1.04D-03	1.91D 02	5.68D-02
11, 8, 4, -2	-47.9	8.90D-04	1.64D 02	2.79D-01
11, 8, 5, 0	-62.8	6.01D-04	1.11D 02	1.44D-01
11, 8, 6, 2	-91.0	7.18D-03	1.32D 03	1.20D 00
11, 8, 8, 6	-891.9	7.44D-04	1.37D 02	1.28D-02
12, 8, 5, -1	-54.4	4.03D-04	7.41D 01	1.11D-01
12, 8, 6, 1	-74.3	1.14D-03	2.10D 02	2.32D-01
12, 8, 7, 3	-117.3	6.01D-04	1.11D 02	7.77D-02
13, 8, 7, 2	-91.0	1.78D-03	3.28D 02	2.96D-01
13, 8, 8, 4	-165.2	3.02D-04	5.55D 01	2.78D-02
13, 8, 9, 6	-891.9	3.18D-04	5.85D 01	5.46D-03
14, 8, 6, -1	-54.4	8.16D-04	1.50D 02	2.25D-01
14, 8, 7, 1	-74.3	1.58D-03	2.90D 02	3.20D-01
14, 8, 8, 3	-117.3	1.70D-03	3.13D 02	2.19D-01
15, 8, 6, -2	-47.9	4.43D-04	8.16D 01	1.38D-01
15, 8, 7, 0	-62.8	4.28D-04	7.88D 01	1.02D-01
15, 8, 8, 2	-91.0	2.41D-03	4.43D 02	4.00D-01
15, 8, 9, 4	-165.2	1.01D-03	1.85D 02	9.27D-02
16, 8, 7, -1	-54.4	7.79D-04	1.44D 02	2.14D-01
16, 8, 8, 1	-74.3	8.07D-04	1.49D 02	1.63D-01
16, 8, 9, 3	-117.3	1.71D-03	3.16D 02	2.21D-01
16, 8, 10, 5	-278.7	5.03D-04	9.26D 01	2.75D-02
17, 8, 7, -2	-47.9	2.96D-04	5.46D 01	9.18D-02
17, 8, 8, 0	-62.8	4.55D-04	8.37D 01	1.08D-01
17, 8, 9, 2	-91.0	1.14D-03	2.11D 02	1.90D-01
17, 8, 10, 4	-165.2	8.77D-04	1.62D 02	8.07D-02
17, 8, 11, 6	-891.9	5.85D-04	1.08D 02	1.00D-02
18, 8, 8, -1	-54.4	4.40D-04	8.09D 01	1.20D-01
18, 8, 10, 3	-117.3	8.65D-04	1.59D 02	1.11D-01
18, 8, 11, 5	-278.7	5.05D-04	9.29D 01	2.76D-02
19, 8, 9, 0	-62.8	3.34D-04	6.15D 01	7.94D-02
19, 8, 10, 2	-91.0	3.99D-04	7.34D 01	6.59D-02
19, 8, 11, 4	-165.2	5.39D-04	9.93D 01	4.95D-02
19, 8, 12, 6	-891.9	8.59D-04	1.58D 02	1.47D-02
20, 8, 11, 3	-117.3	3.84D-04	7.07D 01	4.94D-02
20, 8, 12, 5	-278.7	3.78D-04	6.97D 01	2.07D-02
16, 16, 7, 0	-31.4	1.91D-03	3.51D 02	9.09D-01
16, 16, 8, 2	-37.2	1.73D-03	3.19D 02	7.01D-01
16, 16, 9, 4	-45.5	3.19D-04	5.87D 01	1.06D-01
17, 16, 7, -1	-29.1	3.54D-04	6.52D 01	1.81D-01

SATELLITE 66 56A

S = 8 REV./DAY PERIGEE HEIGHT = 2114. KM.

A = 1.6542 E.R. E = 0.1951 I = 84.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
17.16, 8, 1	-34.0	2.90D-04	5.34D 01	1.28D-01
17.16, 9, 3	-40.9	5.84D-04	1.08D 02	2.15D-01
18.16, 8, 0	-31.4	6.94D-04	1.28D 02	3.30D-01
18.16, 9, 2	-37.2	4.89D-04	9.01D 01	1.98D-01
19.16, 10, 3	-40.9	3.20D-04	5.88D 01	1.17D-01
20.16, 9, 0	-31.4	3.18D-04	5.86D 01	1.51D-01

SATELLITE 66 56B

S = 8 REV./DAY PERIGEE HEIGHT = 4123. KM.

A = 1.6631 E.R. E = 0.0100 I = 86.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
9, 8, 4, 0	-12.8	4.15D-04	7.69D 01	4.75D-01

SATELLITE 62 68B

S = 8 REV./DAY PERIGEE HEIGHT = 1331. KM.

A = 1.6852 E.R. E = 0.2828 I = 47.50 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
9, 8, 4, 0	-3.9	3.16D-04	5.93D 01	1.07D 00

SATELLITE 62 68A

S = 8 REV./DAY PERIGEE HEIGHT = 1367. KM.

A = 1.6865 E.R. E = 0.2800 I = 47.50 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
9, 8, 4, 0	-3.8	2.87D-04	5.38D 01	9.97D-01

SATELLITE 68 26B

S = 7 REV./DAY PERIGEE HEIGHT = 560. KM.

A = 1.8228 E.R. E = 0.4032 I = 100.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
7, 7, 2, -2	-10.8	2.89D-04	5.86D 01	4.89D-01
7, 7, 3, 0	-11.3	5.34D-03	1.08D 03	8.67D 00
7, 7, 4, 2	-11.8	4.83D-03	9.81D 02	7.51D 00
7, 7, 5, 4	-12.4	3.56D-04	7.23D 01	5.28D-01
8, 7, 3, -1	-11.0	1.29D-03	2.63D 02	2.13D 00
8, 7, 4, 1	-11.5	1.86D-03	3.77D 02	2.93D 00
8, 7, 5, 3	-12.1	2.55D-04	5.17D 01	3.84D-01
9, 7, 3, -2	-10.8	4.35D-04	8.82D 01	7.24D-01
9, 7, 4, 0	-11.3	4.83D-04	9.80D 01	7.72D-01
9, 7, 5, 2	-11.8	1.19D-03	2.42D 02	1.83D 00
10, 7, 5, 1	-11.5	2.19D-03	4.43D 02	3.39D 00
10, 7, 6, 3	-12.1	2.66D-04	5.40D 01	3.95D-01
11, 7, 5, 0	-11.3	9.15D-04	1.86D 02	1.44D 00
11, 7, 6, 2	-11.8	7.11D-04	1.44D 02	1.07D 00
12, 7, 5, -1	-11.0	3.48D-04	7.05D 01	5.54D-01
12, 7, 6, 1	-11.5	9.82D-04	1.99D 02	1.50D 00
13, 7, 6, 0	-11.3	3.98D-04	8.08D 01	6.17D-01
14, 7, 6, -1	-11.0	4.50D-04	9.13D 01	7.06D-01
14, 7, 7, 1	-11.5	5.77D-04	1.17D 02	8.70D-01
15, 7, 7, 0	-11.3	6.83D-04	1.39D 02	1.04D 00
16, 7, 7, -1	-11.0	6.53D-04	1.32D 02	1.01D 00
16, 7, 8, 1	-11.5	4.75D-04	9.65D 01	7.05D-01
17, 7, 7, -2	-10.8	3.52D-04	7.13D 01	5.50D-01
17, 7, 8, 0	-11.3	5.29D-04	1.07D 02	7.95D-01
18, 7, 8, -1	-11.0	4.19D-04	8.51D 01	6.38D-01
18, 7, 10, 3	-12.1	2.49D-04	5.05D 01	3.49D-01
19, 7, 8, -2	-10.8	2.62D-04	5.32D 01	4.04D-01
20, 7, 11, 3	-12.1	2.77D-04	5.62D 01	3.83D-01
14, 14, 6, 0	-5.6	2.50D-04	5.08D 01	7.70D-01
14, 14, 7, 2	-5.8	4.63D-04	9.40D 01	1.40D 00
15, 14, 7, 1	-5.7	3.51D-04	7.12D 01	1.06D 00
16, 14, 7, 0	-5.6	4.50D-04	9.13D 01	1.36D 00
17, 14, 8, 1	-5.7	3.27D-04	6.64D 01	9.74D-01
17, 14, 9, 3	-5.8	3.36D-04	6.82D 01	9.80D-01
18, 14, 8, 0	-5.6	3.47D-04	7.05D 01	1.04D 00
19, 14, 10, 3	-5.8	2.68D-04	5.43D 01	7.70D-01
20, 14, 10, 2	-5.8	2.52D-04	5.11D 01	7.26D-01

SATELLITE 63 13A

S = 6 REV./DAY PERIGEE HEIGHT = 980. KM.

A = 1.9228 E.R. E = 0.4000 I = 42.70 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
7, 6, 3, 0	2.8	2.44D-04	5.23D 01	2.82D 00

SATELLITE 63 31B

S = 4 REV./DAY PERIGEE HEIGHT = 345. KM.

A = 2.7028 E.R. E = 0.6100 I = 32.70 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
4, 4, 1, -1	-5.6	5.31D-04	1.60D 02	4.27D 00
4, 4, 2, 1	-5.5	2.64D-04	7.93D 01	2.18D 00
5, 4, 2, 0	-5.5	8.06D-04	2.43D 02	6.40D 00
6, 4, 2, -1	-5.6	1.74D-03	5.23D 02	1.33D 01
5, 4, 3, 1	-5.5	1.49D-03	4.47D 02	1.16D 01
7, 4, 3, 0	-5.5	8.70D-04	2.62D 02	6.56D 00
7, 4, 4, 2	-5.4	2.27D-04	6.84D 01	1.76D 00
8, 4, 3, -1	-5.6	2.67D-04	8.03D 01	1.94D 00
8, 4, 4, 1	-5.5	7.72D-04	2.32D 02	5.74D 00
9, 4, 4, 0	-5.5	2.43D-04	7.31D 01	1.74D 00
9, 4, 5, 2	-5.4	1.82D-04	5.48D 01	1.34D 00
10, 4, 5, 1	-5.5	3.89D-04	1.17D 02	2.76D 00

SATELLITE 66 1108

S = 3 REV./DAY PERIGEE HEIGHT = 168. KM.

A = 3.2459 E.R. E = 0.6838 I = 31.00 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
3, 3, 0, -2	-10.9	9.50D-04	3.43D 02	6.65D 00
3, 3, 1, 0	-10.4	1.31D-02	4.73D 03	9.56D 01
3, 3, 2, 2	-10.0	5.88D-04	2.13D 02	4.47D 00
4, 3, 1, -1	-10.6	6.00D-03	2.17D 03	4.21D 01
4, 3, 2, 1	-10.2	6.00D-03	2.17D 03	4.37D 01
5, 3, 2, 0	-10.4	5.54D-03	2.00D 03	3.88D 01
5, 3, 3, 2	-10.0	9.94D-04	3.59D 02	7.24D 00
6, 3, 2, -1	-10.6	1.78D-04	6.43D 01	1.20D 00
6, 3, 3, 1	-10.2	5.42D-04	1.96D 02	3.80D 00
7, 3, 2, -2	-10.9	4.35D-04	1.57D 02	2.82D 00
7, 3, 3, 0	-10.4	1.70D-03	6.15D 02	1.15D 01
7, 3, 4, 2	-10.0	9.84D-04	3.56D 02	6.89D 00
8, 3, 4, 1	-10.2	3.12D-04	1.13D 02	2.10D 00
9, 3, 5, 2	-10.0	2.13D-04	7.71D 01	1.44D 00
10, 3, 4, -1	-10.6	4.53D-04	1.64D 02	2.84D 00
10, 3, 5, 1	-10.2	4.39D-04	1.58D 02	2.85D 00
10, 3, 6, 3	-9.8	3.22D-04	1.16D 02	2.17D 00
11, 3, 5, 0	-10.4	4.06D-04	1.47D 02	2.55D 00
11, 3, 6, 2	-10.0	4.40D-04	1.59D 02	2.86D 00
12, 3, 7, 3	-9.8	1.54D-04	5.57D 01	1.00D 00
13, 3, 6, 0	-10.4	1.44D-04	5.21D 01	8.75D-01
14, 3, 6, -1	-10.6	1.72D-04	6.20D 01	1.01D 00
14, 3, 7, 1	-10.2	3.32D-04	1.20D 02	2.01D 00
14, 3, 8, 3	-9.8	1.56D-04	5.63D 01	9.77D-01
15, 3, 7, -1	-10.6	2.17D-04	7.86D 01	1.24D 00
16, 3, 8, 1	-10.2	2.06D-04	7.46D 01	1.21D 00
17, 3, 8, 0	-10.4	2.02D-04	7.31D 01	1.15D 00
17, 3, 9, 2	-10.0	2.10D-04	7.60D 01	1.23D 00
19, 3, 9, 0	-10.4	1.74D-04	6.28D 01	9.58D-01
20, 3, 10, 1	-10.2	1.51D-04	5.45D 01	8.32D-01
7, 6, 2, -1	-5.3	2.80D-04	1.01D 02	3.74D 00
7, 6, 3, 1	-5.1	2.35D-04	8.49D 01	3.20D 00
8, 6, 2, -2	-5.3	1.58D-04	5.70D 01	2.05D 00
8, 6, 3, 0	-5.2	6.60D-04	2.39D 02	8.76D 00
8, 6, 4, 2	-5.1	2.14D-04	7.72D 01	2.89D 00
13, 6, 6, 1	-5.1	1.80D-04	6.52D 01	2.21D 00

SATELLITE 66 96A

S = 2 REV./DAY PERIGEE HEIGHT = 3196. KM.

A = 4.1640 E.R. E = 0.6395 I = 17.40 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	937.5	5.40D 01	2.50D 07	8.88D 03
2, 2, 1, 1	-1185.5	2.39D 01	1.11D 07	3.11D 03
3, 2, 0, -2	494.6	9.44D-02	4.38D 04	2.95D 01
3, 2, 1, 0	8964.5	1.74D 03	8.07D 08	2.99D 04
3, 2, 2, 2	-556.0	1.84D-01	8.51D 04	5.08D 01
4, 2, 1, -1	937.5	3.23D 00	1.50D 06	5.32D 02
4, 2, 2, 1	-1185.5	5.65D 00	2.62D 06	7.34D 02
5, 2, 1, -2	494.6	1.34D-01	6.19D 04	4.18D 01
5, 2, 2, 0	8964.5	4.72D 02	2.19D 08	8.12D 03
5, 2, 3, 2	-556.0	1.91D-01	8.86D 04	5.28D 01
6, 2, 2, -1	937.5	4.02D-01	1.86D 05	6.63D 01
6, 2, 3, 1	-1185.5	1.65D 00	7.64D 05	2.14D 02
7, 2, 2, -2	494.6	7.42D-02	3.44D 04	2.32D 01
7, 2, 3, 0	8964.5	1.10D 02	5.11D 07	1.89D 03
7, 2, 4, 2	-556.0	1.13D-01	5.23D 04	3.11D 01
8, 2, 4, 1	-1185.5	1.85D-01	8.56D 04	2.39D 01
9, 2, 4, 0	8964.5	5.19D 00	2.41D 06	8.92D 01
10, 2, 4, -1	937.5	3.19D-02	1.48D 04	5.26D 00
10, 2, 5, 1	-1185.5	1.29D-01	5.98D 04	1.67D 01
11, 2, 5, 0	8964.5	9.54D-01	4.42D 05	1.64D 01
12, 2, 6, 1	-1185.5	2.65D-02	1.23D 04	3.44D 00
13, 2, 6, 0	8964.5	1.03D-01	4.75D 04	1.76D 00
15, 2, 7, 0	8964.5	1.65D-01	7.67D 04	2.85D 00
17, 2, 8, 0	8964.5	1.49D-01	6.89D 04	2.56D 00
19, 2, 9, 0	8964.5	5.09D-02	2.36D 04	8.75D-01

SATELLITE 66 96A

S = 2 REV./DAY PERIGEE HEIGHT = 3196. KM.

A = 4.1640 E.R. E = 0.6395 I = 17.40 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
4, 4, 0, -2	468.8	9.03D-02	4.19D 04	2.97D 01
4, 4, 1, 0	4482.3	1.85D 01	8.58D 06	6.37D 02
4, 4, 2, 2	-592.7	2.94D-02	1.36D 04	7.64D 00
5, 4, 1, -1	848.8	3.12D-01	1.44D 05	5.66D 01
5, 4, 2, 1	-1366.1	8.27D-01	3.83D 05	9.32D 01
6, 4, 1, -2	468.8	3.90D-02	1.81D 04	1.29D 01
6, 4, 2, 0	4482.3	3.96D 01	1.83D 07	1.36D 03
6, 4, 3, 2	-592.7	1.07D-01	4.94D 04	2.76D 01
7, 4, 2, -1	848.8	2.43D-01	1.13D 05	4.42D 01
7, 4, 3, 1	-1366.1	6.57D-01	3.05D 05	7.40D 01
8, 4, 3, 0	4482.3	9.05D 00	4.20D 06	3.11D 02
8, 4, 4, 2	-592.7	4.06D-02	1.88D 04	1.05D 01
9, 4, 3, -1	848.8	4.61D-02	2.14D 04	8.38D 00
9, 4, 4, 1	-1366.1	2.00D-01	9.26D 04	2.25D 01
10, 4, 4, 0	4482.3	2.58D 00	1.20D 06	8.89D 01
11, 4, 5, 1	-1366.1	4.79D-02	2.22D 04	5.40D 00
12, 4, 5, 0	4482.3	9.80D-02	4.54D 04	3.37D 00
6, 6, 2, 1	-1611.8	1.06D-01	4.93D 04	1.02D 01
7, 6, 2, 0	2988.2	1.44D 00	6.70D 05	7.45D 01
8, 6, 2, -1	775.3	1.05D-01	4.87D 04	2.09D 01
8, 6, 3, 1	-1611.8	4.02D-01	1.86D 05	3.84D 01
9, 6, 3, 0	2988.2	2.80D-01	1.30D 05	1.44D 01
10, 6, 4, 1	-1611.8	5.44D-02	2.52D 04	5.20D 00
11, 6, 4, 0	2988.2	2.08D-01	9.65D 04	1.07D 01
13, 6, 5, 0	2988.2	1.76D-01	8.14D 04	9.06D 00
15, 6, 6, 0	2988.2	7.88D-02	3.65D 04	4.07D 00
16, 6, 7, 1	-1611.8	2.20D-02	1.02D 04	2.10D 00
17, 6, 7, 0	2988.2	3.21D-02	1.49D 04	1.66D 00
8, 8, 2, 0	2241.1	4.54D-02	2.10D 04	3.12D 00
9, 8, 3, 1	-1965.1	3.41D-02	1.58D 04	2.67D 00
10, 8, 3, 0	2241.1	4.02D-02	1.86D 04	2.76D 00
14, 8, 5, 0	2241.1	2.44D-02	1.13D 04	1.68D 00
16, 8, 6, 0	2241.1	2.62D-02	1.21D 04	1.80D 00

SATELLITE 66 92A

S = 2 REV./DAY PERIGEE HEIGHT = 269, KM.

A = 4.1605 E.R. E = 0.7495 I = 64.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	490.8	9.12D 00	4.23D 06	2.86D 03
2, 2, 1, 1	468.2	5.92D 01	2.74D 07	1.95D 04
2, 2, 2, 3	447.6	5.10D-02	2.36D 04	1.76D 01
3, 2, 0, -2	503.0	2.30D-01	1.07D 05	7.06D 01
3, 2, 1, 0	479.3	3.41D 00	1.58D 06	1.10D 03
3, 2, 2, 2	457.7	7.72D 00	3.58D 06	2.60D 03
4, 2, 1, -1	490.8	1.70D 00	7.88D 05	5.35D 02
4, 2, 2, 1	468.2	1.31D 00	6.05D 05	4.30D 02
4, 2, 3, 3	447.6	1.31D 00	6.07D 05	4.51D 02
5, 2, 1, -2	503.0	5.35D-01	2.48D 05	1.64D 02
5, 2, 2, 0	479.3	3.45D 00	1.60D 06	1.11D 03
5, 2, 3, 2	457.7	7.34D-01	3.40D 05	2.47D 02
5, 2, 4, 4	438.0	3.20D-01	1.48D 05	1.13D 02
6, 2, 1, -3	515.7	6.14D-02	2.84D 04	1.84D 01
6, 2, 2, -1	490.8	8.79D-01	4.07D 05	2.77D 02
6, 2, 3, 1	468.2	1.58D 00	7.32D 05	5.21D 02
6, 2, 4, 3	447.6	1.84D-01	8.53D 04	6.36D 01
6, 2, 5, 5	428.7	3.59D-02	1.66D 04	1.29D 01
7, 2, 2, -2	503.0	3.74D-01	1.73D 05	1.15D 02
7, 2, 3, 0	479.3	1.64D 00	7.58D 05	5.28D 02
7, 2, 4, 2	457.7	1.39D 00	6.46D 05	4.71D 02
7, 2, 5, 4	438.0	1.12D-01	5.20D 04	3.97D 01
8, 2, 3, -1	490.8	1.03D-01	4.75D 04	3.24D 01
8, 2, 4, 1	468.2	2.31D-01	1.07D 05	7.64D 01
8, 2, 5, 3	447.6	1.21D-01	5.58D 04	4.17D 01
9, 2, 4, 0	479.3	8.70D-02	4.03D 04	2.81D 01
9, 2, 5, 2	457.7	1.40D-01	6.49D 04	4.74D 01
9, 2, 6, 4	438.0	5.21D-02	2.41D 04	1.84D 01
10, 2, 4, -1	490.8	3.02D-02	1.40D 04	9.52D 00
10, 2, 5, 1	468.2	6.08D-02	2.82D 04	2.01D 01
10, 2, 6, 3	447.6	1.08D-01	5.01D 04	3.74D 01
10, 2, 7, 5	428.7	3.18D-02	1.47D 04	1.15D 01
11, 2, 4, -2	503.0	5.02D-02	2.32D 04	1.55D 01
11, 2, 5, 0	479.3	7.36D-02	3.41D 04	2.38D 01
11, 2, 7, 4	438.0	2.70D-02	1.25D 04	9.58D 00
12, 2, 4, -3	515.7	2.97D-02	1.37D 04	8.92D 00
12, 2, 5, -1	490.8	8.58D-02	3.97D 04	2.71D 01
12, 2, 6, 1	468.2	8.68D-02	4.02D 04	2.88D 01
13, 2, 5, -2	503.0	2.91D-02	1.35D 04	8.99D 00
13, 2, 6, 0	479.3	5.48D-02	2.54D 04	1.78D 01
13, 2, 7, 2	457.7	3.88D-02	1.80D 04	1.32D 01
14, 2, 6, -1	490.8	4.98D-02	2.31D 04	1.58D 01
14, 2, 7, 1	468.2	6.37D-02	2.95D 04	2.12D 01
14, 2, 8, 3	447.6	3.35D-02	1.55D 04	1.16D 01
15, 2, 7, 0	479.3	4.52D-02	2.10D 04	1.47D 01
15, 2, 8, 2	457.7	4.07D-02	1.89D 04	1.38D 01
16, 2, 7, -1	490.8	2.78D-02	1.29D 04	8.80D 00
16, 2, 8, 1	468.2	4.61D-02	2.14D 04	1.53D 01
16, 2, 9, 3	447.6	3.39D-02	1.57D 04	1.18D 01
19, 2, 9, 0	479.3	2.53D-02	1.17D 04	8.24D 00
4, 4, 1, 0	239.6	7.44D-01	3.45D 05	4.79D 02
4, 4, 2, 2	234.1	1.36D 00	6.28D 05	8.93D 02
4, 4, 3, 4	228.8	6.32D-02	2.93D 04	4.26D 01

SATELLITE 66 92A

S = 2 REV./DAY PERIGEE HEIGHT = 269. KM.

A = 4.1605 E.R. E = 0.7495 I = 64.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
5, 4, 1, -1	242.5	7.67D-02	3.55D 04	4.88D 01
5, 4, 2, 1	236.8	6.66D-01	3.09D 05	4.34D 02
5, 4, 3, 3	231.4	5.52D-01	2.56D 05	3.68D-02
6, 4, 2, 0	239.6	8.40D-01	3.89D 05	5.42D 02
6, 4, 3, 2	234.1	1.07D 00	4.94D 05	7.04D 02
6, 4, 4, 4	228.8	5.86D-01	2.72D 05	3.96D 02
7, 4, 2, -1	242.5	4.05D-02	1.88D 04	2.58D 01
7, 4, 3, 1	236.8	4.02D-01	1.86D 05	2.62D 02
7, 4, 4, 3	231.4	1.76D-01	8.15D 04	1.18D 02
7, 4, 5, 5	226.3	6.96D-02	3.22D 04	4.76D 01
8, 4, 3, 0	239.6	1.13D-01	5.22D 04	7.28D 01
8, 4, 4, 2	234.1	3.86D-01	1.79D 05	2.55D 02
8, 4, 5, 4	228.8	8.36D-02	3.87D 04	5.65D 01
8, 4, 6, 6	223.8	2.37D-02	1.10D 04	1.64D 01
9, 4, 4, 1	236.8	6.02D-02	2.79D 04	3.94D 01
9, 4, 5, 3	231.4	1.07D-01	4.98D 04	7.19D 01
10, 4, 3, -2	245.4	2.26D-02	1.05D 04	1.43D 01
10, 4, 4, 0	239.6	3.33D-02	1.54D 04	2.15D 01
10, 4, 5, 2	234.1	7.32D-02	3.39D 04	4.85D 01
10, 4, 6, 4	228.8	8.41D-02	3.89D 04	5.69D 01
15, 4, 7, 1	236.8	3.89D-02	1.80D 04	2.55D 01
15, 4, 8, 3	231.4	3.52D-02	1.63D 04	2.36D 01
16, 4, 8, 2	234.1	2.59D-02	1.20D 04	1.72D 01
6, 6, 2, 1	158.5	2.74D-01	1.27D 05	2.67D 02
6, 6, 3, 3	156.1	2.59D-01	1.20D 05	2.56D 02
6, 6, 4, 5	153.7	2.41D-02	1.11D 04	2.42D 01
7, 6, 3, 2	157.3	5.13D-01	2.38D 05	5.04D 02
7, 6, 4, 4	154.9	3.16D-01	1.46D 05	3.16D 02
8, 6, 2, -1	161.0	4.56D-02	2.11D 04	4.38D 01
8, 6, 3, 1	158.5	1.66D-01	7.68D 04	1.62D 02
8, 6, 4, 3	156.1	4.42D-01	2.04D 05	4.38D 02
8, 6, 5, 5	153.7	2.05D-01	9.50D 04	2.06D 02
9, 6, 4, 2	157.3	3.81D-02	1.76D 04	3.75D 01
9, 6, 5, 4	154.9	3.23D-02	1.49D 04	3.23D 01
10, 6, 5, 3	156.1	3.77D-02	1.75D 04	3.75D 01
11, 6, 6, 4	154.9	2.70D-02	1.25D 04	2.71D 01
13, 6, 6, 2	157.3	3.30D-02	1.53D 04	3.25D 01
15, 6, 7, 2	157.3	2.35D-02	1.09D 04	2.33D 01
8, 8, 2, 0	119.8	3.83D-02	1.77D 04	4.94D 01
8, 8, 3, 2	118.4	1.82D-01	8.45D 04	2.38D 02
8, 8, 4, 4	117.1	1.29D-01	5.98D 04	1.71D 02
9, 8, 3, 1	119.1	3.17D-02	1.47D 04	4.13D 01
9, 8, 4, 3	117.7	1.61D-01	7.44D 04	2.11D 02
9, 8, 5, 5	116.4	8.36D-02	3.87D 04	1.11D 02
10, 8, 5, 4	117.1	5.66D-02	2.62D 04	7.49D 01
10, 8, 6, 6	115.7	2.30D-02	1.07D 04	3.08D 01
10, 10, 4, 3	94.5	2.35D-02	1.09D 04	3.85D 01
11, 10, 5, 4	94.1	2.17D-02	1.00D 04	3.57D 01
13, 12, 6, 5	78.3	2.28D-02	1.05D 04	4.51D 01

SATELLITE 67 95A

S = 2 REV./DAY PERIGEE HEIGHT = 331. KM.

A = 4.1577 E.R. E = 0.7470 I = 64.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	245.1	2.27D 00	1.05D 06	1.43D 03
2, 2, 1, 1	239.5	1.53D 01	7.07D 06	9.83D 03
3, 2, 0, -2	248.1	5.56D-02	2.58D 04	3.46D 01
3, 2, 1, 0	242.3	8.53D-01	3.95D 05	5.43D 02
3, 2, 2, 2	236.7	2.01D 00	9.32D 05	1.31D 03
4, 2, 1, -1	245.1	4.11D-01	1.90D 05	2.59D 02
4, 2, 2, 1	239.5	3.31D-01	1.53D 05	2.14D 02
4, 2, 3, 3	234.0	3.45D-01	1.60D 05	2.28D 02
5, 2, 1, -2	248.1	1.24D-01	5.76D 04	7.76D 01
5, 2, 2, 0	242.3	8.46D-01	3.92D 05	5.41D 02
5, 2, 3, 2	236.7	1.88D-01	8.69D 04	1.23D 02
5, 2, 4, 4	231.4	8.49D-02	3.93D 04	5.68D 01
6, 2, 2, -1	245.1	2.08D-01	9.64D 04	1.32D 02
6, 2, 3, 1	239.5	3.92D-01	1.82D 05	2.54D 02
6, 2, 4, 3	234.0	4.76D-02	2.20D 04	3.16D 01
7, 2, 2, -2	248.1	8.55D-02	3.96D 04	5.35D 01
7, 2, 3, 0	242.3	3.93D-01	1.82D 05	2.52D 02
7, 2, 4, 2	236.7	3.50D-01	1.62D 05	2.30D 02
7, 2, 5, 4	231.4	2.93D-02	1.36D 04	1.97D 01
8, 2, 3, -1	245.1	2.38D-02	1.10D 04	1.51D 01
8, 2, 4, 1	239.5	5.63D-02	2.61D 04	3.65D 01
8, 2, 5, 3	234.0	3.06D-02	1.42D 04	2.03D 01
9, 2, 5, 2	236.7	3.45D-02	1.60D 04	2.27D 01
10, 2, 6, 3	234.0	2.70D-02	1.25D 04	1.80D 01
4, 4, 1, 0	121.1	1.85D-01	8.54D 04	2.35D 02
4, 4, 2, 2	119.7	3.43D-01	1.59D 05	4.43D 02
5, 4, 2, 1	120.4	1.65D-01	7.66D 04	2.13D 02
5, 4, 3, 3	119.0	1.40D-01	6.46D 04	1.81D 02
6, 4, 2, 0	121.1	2.04D-01	9.45D 04	2.61D 02
6, 4, 3, 2	119.7	2.65D-01	1.23D 05	3.43D 02
6, 4, 4, 4	118.4	1.48D-01	6.86D 04	1.94D 02
7, 4, 3, 1	120.4	9.78D-02	4.53D 04	1.26D 02
7, 4, 4, 3	119.0	4.37D-02	2.02D 04	5.69D 01
8, 4, 3, 0	121.1	2.69D-02	1.24D 04	3.45D 01
8, 4, 4, 2	119.7	9.39D-02	4.35D 04	1.22D 02
9, 4, 5, 3	119.0	2.62D-02	1.21D 04	3.43D 01
6, 6, 2, 1	80.4	6.71D-02	3.11D 04	1.29D 02
6, 6, 3, 3	79.8	6.43D-02	2.98D 04	1.25D 02
7, 6, 3, 2	80.1	1.25D-01	5.80D 04	2.43D 02
7, 6, 4, 4	79.5	7.81D-02	3.61D 04	1.52D 02
8, 6, 3, 1	80.4	3.99D-02	1.84D 04	7.70D 01
8, 6, 4, 3	79.8	1.07D-01	4.98D 04	2.09D 02
8, 6, 5, 5	79.2	5.05D-02	2.34D 04	9.90D 01
9, 8, 3, 2	60.2	4.40D-02	2.04D 04	1.14D 02
8, 8, 4, 4	59.9	3.14D-02	1.45D 04	8.16D 01
9, 8, 4, 3	60.0	3.86D-02	1.79D 04	1.00D 02

SATELLITE 67 101A

S = 2 REV./DAY PERIGEE HEIGHT = 527. KM.

A = 4.1577 E.R. E = 0.7396 I = 64.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	242.5	2.21D 00	1.02D 06	1.40D 03
2, 2, 1, 1	237.6	1.44D 01	6.66D 06	9.33D 03
3, 2, 0, -2	245.1	5.30D-02	2.45D 04	3.34D 01
3, 2, 1, 0	240.0	8.00D-01	3.70D 05	5.15D 02
3, 2, 2, 2	235.2	1.84D 00	8.50D 05	1.21D 03
4, 2, 1, -1	242.5	3.66D-01	1.69D 05	2.33D 02
4, 2, 2, 1	237.6	3.06D-01	1.42D 05	1.99D 02
4, 2, 3, 3	232.8	3.04D-01	1.41D 05	2.02D 02
5, 2, 1, -2	245.1	1.06D-01	4.92D 04	6.71D 01
5, 2, 2, 0	240.0	7.39D-01	3.42D 05	4.76D 02
5, 2, 3, 2	235.2	1.69D-01	7.81D 04	1.11D 02
5, 2, 4, 4	230.5	7.26D-02	3.36D 04	4.88D 01
6, 2, 2, -1	242.5	1.74D-01	8.07D 04	1.11D 02
6, 2, 3, 1	237.6	3.33D-01	1.54D 05	2.17D 02
6, 2, 4, 3	232.8	4.13D-02	1.91D 04	2.75D 01
7, 2, 2, -2	245.1	6.86D-02	3.17D 04	4.34D 01
7, 2, 3, 0	240.0	3.21D-01	1.49D 05	2.07D 02
7, 2, 4, 2	235.2	2.88D-01	1.33D 05	1.90D 02
7, 2, 5, 4	230.5	2.45D-02	1.14D 04	1.65D 01
8, 2, 4, 1	237.6	4.44D-02	2.06D 04	2.92D 01
8, 2, 5, 3	232.8	2.44D-02	1.13D 04	1.63D 01
9, 2, 5, 2	235.2	2.65D-02	1.22D 04	1.75D 01
4, 4, 1, 0	120.0	1.66D-01	7.67D 04	2.13D 02
4, 4, 2, 2	118.8	3.05D-01	1.41D 05	3.97D 02
5, 4, 2, 1	119.4	1.45D-01	6.71D 04	1.88D 02
5, 4, 3, 3	118.2	1.20D-01	5.55D 04	1.57D 02
6, 4, 2, 0	120.0	1.72D-01	7.96D 04	2.22D 02
6, 4, 3, 2	118.8	2.26D-01	1.05D 05	2.95D 02
6, 4, 4, 4	117.6	1.23D-01	5.70D 04	1.62D 02
7, 4, 3, 1	119.4	8.02D-02	3.71D 04	1.04D 02
7, 4, 4, 3	118.2	3.63D-02	1.68D 04	4.77D 01
8, 4, 4, 2	118.8	7.47D-02	3.46D 04	9.78D 01
6, 6, 2, 1	79.7	5.69D-02	2.64D 04	1.11D 02
6, 6, 3, 3	79.2	5.39D-02	2.49D 04	1.05D 02
7, 6, 3, 2	79.5	1.03D-01	4.79D 04	2.02D 02
7, 6, 4, 4	78.9	6.33D-02	2.93D 04	1.24D 02
8, 6, 3, 1	79.7	3.13D-02	1.45D 04	6.10D 01
8, 6, 4, 3	79.2	8.62D-02	3.99D 04	1.69D 02
8, 6, 5, 5	78.7	3.97D-02	1.84D 04	7.84D 01
8, 8, 3, 2	59.7	3.53D-02	1.63D 04	9.18D 01
8, 8, 4, 4	59.4	2.48D-02	1.15D 04	6.50D 01
9, 8, 4, 3	59.5	3.00D-02	1.39D 04	7.85D 01

SATELLITE 64 49E

S = 2 REV./DAY PERIGEE HEIGHT = 1531. KM.

A = 4.1584 E.R. E = 0.7018 I = 68.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	269.5	2.37D 00	1.10D 06	1.35D 03
2, 2, 1, 1	252.3	1.41D 01	6.51D 06	8.60D 03
3, 2, 0, -2	279.1	5.68D-02	2.63D 04	3.14D 01
3, 2, 1, 0	260.6	2.13D-01	9.87D 04	1.26D 02
3, 2, 2, 2	244.4	1.43D 00	6.63D 05	9.05D 02
4, 2, 1, -1	269.5	2.23D-01	1.03D 05	1.23D 02
4, 2, 2, 1	252.3	7.34D-02	3.40D 04	4.49D 01
4, 2, 3, 3	237.1	1.93D-01	8.92D 04	1.26D 02
5, 2, 1, -2	279.1	6.82D-02	3.16D 04	3.78D 01
5, 2, 2, 0	260.6	3.55D-01	1.64D 05	2.11D 02
5, 2, 3, 2	244.4	4.38D-02	2.03D 04	2.77D 01
5, 2, 4, 4	230.2	3.76D-02	1.74D 04	2.53D 01
6, 2, 2, -1	269.5	9.92D-02	4.59D 04	5.70D 01
6, 2, 3, 1	252.3	1.30D-01	6.02D 04	7.98D 01
7, 2, 2, -2	279.1	4.51D-02	2.09D 04	2.50D 01
7, 2, 3, 0	260.6	1.64D-01	7.58D 04	9.75D 01
7, 2, 4, 2	244.4	9.46D-02	4.38D 04	6.01D 01
4, 4, 1, 0	130.3	1.26D-01	5.82D 04	1.49D 02
4, 4, 2, 2	126.1	2.44D-01	1.13D 05	2.98D 02
5, 4, 2, 1	128.2	7.12D-02	3.30D 04	8.60D 01
5, 4, 3, 3	124.1	7.62D-02	3.53D 04	9.50D 01
6, 4, 2, 0	130.3	1.08D-01	5.00D 04	1.28D 02
6, 4, 3, 2	126.1	6.13D-02	2.84D 04	7.53D 01
6, 4, 4, 4	122.2	6.32D-02	2.93D 04	8.02D 01
7, 4, 3, 1	128.2	3.91D-02	1.81D 04	4.73D 01
8, 4, 4, 2	126.1	2.87D-02	1.33D 04	3.54D 01
6, 6, 2, 1	85.9	3.46D-02	1.60D 04	6.24D 01
6, 6, 3, 3	84.1	3.48D-02	1.61D 04	6.41D 01
7, 6, 3, 2	85.0	4.40D-02	2.04D 04	8.03D 01
7, 6, 4, 4	83.2	3.25D-02	1.50D 04	6.06D 01
8, 6, 3, 1	85.9	2.27D-02	1.05D 04	4.10D 01
8, 6, 4, 3	84.1	2.40D-02	1.11D 04	4.43D 01

SATELLITE 65 30A

S = 2 REV./DAY PERIGEE HEIGHT = 2021. KM.

A = 4.1727 E.R. E = 0.6844 I = 65.30 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	-154.2	8.15D-01	3.79D 05	8.14D 02
2, 2, 1, 1	-156.2	4.67D 00	2.17D 06	4.60D 03
3, 2, 1, 0	-155.2	2.03D-01	9.42D 04	2.01D 02
3, 2, 2, 2	-157.2	4.82D-01	2.24D 05	4.71D 02
4, 2, 1, -1	-154.2	7.37D-02	3.42D 04	7.32D 01
4, 2, 2, 1	-156.2	5.78D-02	2.68D 04	5.67D 01
4, 2, 3, 3	-158.3	6.52D-02	3.03D 04	6.31D 01
5, 2, 2, 0	-155.2	1.32D-01	6.14D 04	1.30D 02
5, 2, 3, 2	-157.2	2.56D-02	1.19D 04	2.49D 01
6, 2, 2, -1	-154.2	2.51D-02	1.17D 04	2.49D 01
6, 2, 3, 1	-156.2	5.01D-02	2.33D 04	4.90D 01
7, 2, 3, 0	-155.2	4.06D-02	1.89D 04	3.99D 01
7, 2, 4, 2	-157.2	3.62D-02	1.68D 04	3.50D 01
4, 4, 1, 0	-77.6	3.87D-02	1.80D 04	7.64D 01
4, 4, 2, 2	-78.1	6.88D-02	3.19D 04	1.35D 02
5, 4, 2, 1	-77.8	2.69D-02	1.25D 04	5.28D 01
6, 4, 2, 0	-77.6	2.70D-02	1.25D 04	5.31D 01
6, 4, 3, 2	-78.1	3.26D-02	1.51D 04	6.37D 01

SATELLITE 67 82A

S = 2 REV./DAY PERIGEE HEIGHT = 323. KM.

A = 4.1513 E.R. E = 0.7469 I = 64.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	114.6	4.98D-01	2.30D 05	6.70D 02
2, 2, 1, 1	113.3	3.43D 00	1.58D 06	4.67D 03
3, 2, 1, 0	114.0	1.89D-01	8.74D 04	2.57D 02
3, 2, 2, 2	112.7	4.58D-01	2.11D 05	6.28D 02
4, 2, 1, -1	114.6	8.99D-02	4.16D 04	1.22D 02
4, 2, 2, 1	113.3	7.43D-02	3.43D 04	1.02D 02
4, 2, 3, 3	112.1	7.92D-02	3.66D 04	1.10D 02
5, 2, 1, -2	115.2	2.69D-02	1.24D 04	3.67D 01
5, 2, 2, 0	114.0	1.88D-01	8.67D 04	2.56D 02
5, 2, 3, 2	112.7	4.26D-02	1.97D 04	5.89D 01
6, 2, 2, -1	114.6	4.55D-02	2.10D 04	6.20D 01
6, 2, 3, 1	113.3	8.80D-02	4.07D 04	1.21D 02
7, 2, 3, 0	114.0	8.71D-02	4.02D 04	1.20D 02
7, 2, 4, 2	112.7	7.94D-02	3.67D 04	1.10D 02
4, 4, 1, 0	57.0	4.09D-02	1.89D 04	1.11D 02
4, 4, 2, 2	56.7	7.70D-02	3.56D 04	2.11D 02
5, 4, 2, 1	56.8	3.69D-02	1.70D 04	1.01D 02
5, 4, 3, 3	56.5	3.15D-02	1.45D 04	8.67D 01
6, 4, 2, 0	57.0	4.52D-02	2.09D 04	1.24D 02
6, 4, 3, 2	56.7	5.94D-02	2.74D 04	1.64D 02
6, 4, 4, 4	56.4	3.36D-02	1.55D 04	9.31D 01
7, 4, 3, 1	56.8	2.18D-02	1.01D 04	6.00D 01
7, 6, 3, 2	37.8	2.80D-02	1.29D 04	1.16D 02
8, 6, 4, 3	37.8	2.41D-02	1.11D 04	1.00D 02

SATELLITE 64 49D

S = 2 REV./DAY PERIGEE HEIGHT = 1415. KM.

A = 4.1515 E.R. E = 0.7057 I = 68.90 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	114.9	4.33D-01	2.00D 05	5.81D 02
2, 2, 1, 1	111.5	2.82D 00	1.30D 06	3.90D 03
3, 2, 1, 0	113.2	3.91D-02	1.81D 04	5.34D 01
3, 2, 2, -2	109.9	3.02D-01	1.39D 05	4.25D 02
4, 2, 1, -1	114.9	4.22D-02	1.95D 04	5.70D 01
4, 2, 3, 3	108.3	4.26D-02	1.97D 04	6.10D 01
5, 2, 2, 0	113.2	7.02D-02	3.24D 04	9.65D 01
6, 2, 3, 1	111.5	2.70D-02	1.25D 04	3.78D 01
7, 2, 3, 0	113.2	3.35D-02	1.55D 04	4.64D 01
4, 4, 1, 0	56.6	2.47D-02	1.14D 04	6.77D 01
4, 4, 2, -2	55.8	5.01D-02	2.31D 04	1.39D 02
6, 4, 2, 0	56.6	2.19D-02	1.01D 04	6.03D 01

SATELLITE 67 52A

S = 2 REV./DAY PERIGEE HEIGHT = 902. KM.

A = 4.1370 E.R. E = 0.7241 I = 64.80 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	51.8	9.99D-02	4.60D 04	2.98D 02
2, 2, 1, 1	51.6	6.29D-01	2.90D 05	1.88D 03
3, 2, 1, 0	51.7	3.32D-02	1.53D 04	9.97D 01
3, 2, 2, -2	51.5	7.60D-02	3.50D 04	2.29D 02
5, 2, 2, 0	51.7	2.71D-02	1.25D 04	8.25D 01

SATELLITE 66 35A

S = 2 REV./DAY PERIGEE HEIGHT = 1236. KM.

A = 4.1165 E.R. E = 0.7100 I = 65.10 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
2, 2, 0, -1	29.0	3.08D-02	1.41D 04	1.65D 02
2, 2, 1, 1	28.9	1.86D-01	8.53D 04	9.98D 02

SATELLITE 64 06D

S = 1 REV./DAY PERIGEE HEIGHT = 3849. KM.

A = 6.4501 E.R. E = 0.7514 I = 58.30 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
3, 1, 0, -2	26.5	7.01D-05	5.04D 01	1.35D 00
3, 1, 1, 0	26.6	3.54D-03	2.54D 03	6.77D 01
3, 1, 2, 2	26.6	3.25D-03	2.34D 03	6.22D 01
4, 1, 1, -1	26.5	1.12D-04	8.06D 01	2.21D 00
4, 1, 2, 1	26.6	5.81D-04	4.17D 02	1.14D 01
4, 1, 3, 3	26.7	2.19D-04	1.57D 02	4.29D 00
2, 2, 0, 0	13.3	7.97D-04	5.72D 02	2.97D 01
2, 2, 1, 2	13.3	8.06D-03	5.79D 03	3.00D 02
3, 2, 1, 1	13.3	8.32D-04	5.97D 02	3.19D 01
3, 2, 2, 3	13.3	6.73D-04	4.83D 02	2.57D 01
4, 2, 1, 0	13.3	1.49D-04	1.07D 02	5.86D 00
4, 2, 2, 2	13.3	2.75D-04	1.97D 02	1.08D 01
4, 2, 3, 4	13.3	7.37D-05	5.29D 01	2.89D 00
5, 2, 2, 1	13.3	1.78D-04	1.28D 02	7.20D 00
5, 2, 3, 3	13.3	1.01D-04	7.26D 01	4.08D 00
3, 3, 0, 0	8.9	1.24D-04	8.93D 01	7.15D 00
3, 3, 1, 2	8.9	1.74D-03	1.25D 03	1.00D 02
3, 3, 2, 4	8.9	2.56D-04	1.84D 02	1.47D 01
4, 3, 2, 3	8.9	5.12D-04	3.68D 02	3.02D 01
5, 3, 3, 4	8.9	7.07D-05	5.07D 01	4.28D 00
5, 5, 2, 4	5.3	7.83D-05	5.62D 01	7.91D 00

SATELLITE 66 53H

S = 1 REV./DAY PERIGEE HEIGHT = 33630. KM.

A = 6.2726 E.R. E = 0.0 I = 1.50 DEG.

L, M, P, Q	BEAT PERIOD (DAYS)	CENTRAL ANGLE (DEGREES)	TRANSVERSE (METERS)	DELTA A (METERS)
3, 1, 1, 0	12.2	2.69D-04	1.88D 02	1.19D 01
2, 2, 0, 0	6.1	1.71D-03	1.19D 03	1.42D 02
3, 3, 0, 0	4.1	1.06D-04	7.40D 01	1.40D 01

Table 3
Geopotential Constants
**[Combination solution from satellites and surface gravity data,
nonzonal harmonic coefficients (normalized).] [From Reference 4]**

$\times 10^6$				$\times 10^6$				$\times 10^6$				$\times 10^6$							
\bar{J}_{nm}	n	m	\bar{C}_{nm}	\bar{S}_{nm}	\bar{J}_{nm}	n	m	\bar{C}_{nm}	\bar{S}_{nm}	\bar{J}_{nm}	n	m	\bar{C}_{nm}	\bar{S}_{nm}	\bar{J}_{nm}	n	m	\bar{C}_{nm}	\bar{S}_{nm}
2.73	2	2	2.38	-1.35	.13	8	5	-.09	.09	.04	11	8	.04	-.02	.02	14	1	-.01	.02
1.72	3	1	1.71	.23	.30	8	6	-.01	.30	.03	11	9	.03	.01	.04	14	2	-.01	-.04
.98	3	2	.84	-.51	.04	8	7	.02	.04	.03	11	10	-.03	-.01	.07	14	3	.06	-.03
1.57	3	3	.66	1.43	.18	8	8	-.18	.03	.12	11	11	.10	.06	0	14	4	.00	.00
.61	4	1	-.47	-.39	.11	9	1	.11	.00	.11	12	1	-.09	-.07	.06	14	5	.05	-.03
.59	4	2	.35	.48	.06	9	2	.03	.05	.06	12	2	-.06	.02	.03	14	6	.01	-.03
.95	4	3	.92	-.24	.03	9	3	-.03	-.01	.04	12	3	.03	.02	.04	14	7	.03	.02
.30	4	4	.04	.30	.07	9	4	.07	.02	.05	12	4	-.05	.01	.04	14	8	-.03	-.03
.08	5	1	-.06	-.05	.06	9	5	-.04	.04	.02	12	5	.02	.01	.08	14	9	.03	.07
.57	5	2	.53	-.21	.04	9	6	.04	.01	.01	12	6	-.01	.01	.04	14	10	.04	.01
.41	5	3	-.40	.07	.04	9	7	.04	-.02	.04	12	7	-.04	-.02	.04	14	11	.04	.01
.20	5	4	-.20	.02	.13	9	8	.13	.00	.01	12	8	.00	.01	.06	14	12	.05	-.03
.59	5	5	.18	-.56	.09	9	9	.08	.04	.02	12	9	-.01	.02	.04	14	13	.01	.04
.08	6	1	-.08	.01	.07	10	1	.10	-.07	.01	12	10	-.01	.00	.04	14	14	-.04	.02
.27	6	2	.01	-.27	.10	10	2	-.08	-.06	.05	12	11	-.05	-.02	.01	15	1	.01	-.01
.05	6	3	-.04	.03	.09	10	3	-.08	-.05	.01	12	12	-.01	-.01	.04	15	2	-.02	-.03
.49	6	4	-.08	-.48	.10	10	4	-.06	-.08	.04	13	1	.00	.04	.04	15	3	.02	.03
.53	6	5	-.26	-.46	.03	10	5	.02	-.02	.03	13	2	-.03	.01	.01	15	4	.00	.01
.16	6	6	-.02	-.16	.04	10	6	-.04	-.01	.03	13	3	.00	.03	.04	15	5	.03	-.02
.20	7	1	.17	.11	.06	10	7	.04	-.05	.02	13	4	-.01	-.02	.06	15	6	.03	-.05
.36	7	2	.32	.16	.06	10	8	.04	-.05	.04	13	5	.03	-.02	.05	15	7	.03	.04
.18	7	3	.18	.00	.06	10	9	.05	-.04	.06	13	6	-.03	.05	.06	15	8	-.06	.00
.16	7	4	-.16	-.04	.04	10	10	.03	-.02	.02	13	7	-.02	.00	.04	15	9	.00	.04
.07	7	5	.07	-.01	.04	11	1	-.03	.02	.02	13	8	-.02	-.01	.02	15	10	.02	.01
.25	7	6	-.23	.10	.07	11	2	.05	-.05	.05	13	9	.02	.05	.01	15	11	.01	.01
.09	7	7	.07	.06	.08	11	3	.01	-.08	.04	13	10	.04	-.02	.09	15	12	-.07	.05
.01	8	1	-.01	-.01	.03	11	4	-.03	.00	.02	13	11	-.02	.01	.06	15	13	-.05	-.03
.06	8	2	.04	.04	.04	11	5	.03	.02	.06	13	12	-.02	.06	.03	15	14	.01	-.03
.03	8	3	-.03	.00	.04	11	6	-.03	-.02	.07	13	13	-.07	.00	.02	15	15	-.02	-.01
.17	8	4	-.17	-.02	.04	11	7	.03	-.03										

$$(\bar{C}_{nm}, \bar{S}_{nm}) = (C_{nm}, S_{nm}) \left[\frac{(n-m)! (2n+1) 2}{(n+m)!} \right]^{-1/2}$$

$$\bar{J}_{nm} = + (\bar{C}_{nm}^2 + \bar{S}_{nm}^2)^{1/2}$$

The formulae used to calculate $\Delta\Omega$, $\Delta\omega$, and ΔM assumed the tesseral harmonic perturbations could be treated as forced oscillations about an intermediary orbit; in the case of deep resonance, this assumption is obviously violated. Thus, the perturbations calculated for cases of very long beat periods, i.e., ≥ 100 days, must at best be regarded as only order of magnitude estimates. Furthermore, when resonance is deep, small errors in the semi-major axis of an orbit will cause large errors in the computation of beat period (Appendix A).

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APPENDIX A SHALLOW RESONANCE

THE MEAN MEAN MOTION OF A SATELLITE

Resonant satellites are often regarded simply as satellites with mean motion equal to some integer times the rotation rate of the Earth. However, this definition is too inexact to permit computation of precise orbit elements. Complications result primarily from the secular effects of the second zonal harmonic on Ω , ω , and the mean mean motion. The effects of J_2 on ω and Ω are well known. However, a discussion of the mean mean motion of a satellite will be useful for this analysis.

Calculation of the mean mean motion requires a solution for the variation of the semi-major axis of an orbit. Sterne (Reference 1) and others have noted the existence of an exact solution for the semi-major axis of an orbit perturbed by the second zonal harmonic. The existence of this solution is used below to obtain the mean mean motion.

A very simple demonstration of an exact solution for the semi-major axis for the J_2 problem can be obtained from elementary Hamilton-Jacobi theory. The Hamiltonian, F , of the perturbed satellite problem is

$$F = \frac{\mu}{2a} + R,$$

where R is the disturbing function. When F is not explicitly a function of time,

$$F = \text{constant}$$

and is an integral of the motion. This is the case for all zonal harmonics. If we define a_F by

$$F = \text{const.} = \frac{\mu}{2a_F}$$

then, the relation

$$\frac{1}{a_F} = \frac{1}{a} + \frac{2R}{\mu} \quad (2)$$

follows at once, providing a solution for the semi-major axis in terms of initial conditions. To compare this solution with more familiar ones, consider the effects of the 2nd zonal harmonic alone. For this case, Kaula (Reference 2) gives

$$\begin{aligned} R_2 = R_c + R_p &= \frac{-\mu}{a} J_2 \left(\frac{a_e}{a} \right)^2 \left(\frac{3}{4} \sin^2 i - \frac{1}{2} \right) (1 - e^2)^{-3/2} \\ &+ \sum_{p=0}^{\ell} \sum_{q=-\infty}^{+\infty} \mu \frac{a_e^2}{a^3} J_2 F_{20p} (i) G_{2pq} (e) \cos [(2 - 2p)\omega \\ &\quad p, q \neq 1, 0 \\ &+ (2 - 2p + q) M] \end{aligned} \quad (3)$$

Thus, Equation (2) becomes

$$a = a_K + \frac{3}{2} J_2 \frac{a_e^2}{a} \sin^2 i \cos 2(\omega + M) + \text{higher order terms,} \quad (4)$$

where

$$a_K = a_F \left[1 - 2 \left(\frac{a_e}{a} \right)^2 J_2 \left(\frac{3}{4} \sin^2 i - \frac{1}{2} \right) (1 - e^2)^{-3/2} \right] \quad (5)$$

Equation (4) is the same as that of Douglas and Ingram (Reference 3) and Brouwer (Reference 4). The constant a_K is the value of the semi-major axis averaged with respect to mean anomaly.

To obtain the mean mean motion of a satellite, the constant portion of dM/dt must be determined. From Kaula (Reference 2)

$$\frac{dM}{dt} = \frac{\sqrt{\mu}}{a^{3/2}} - \frac{(1 - e^2)}{na^2 e} \frac{\partial R}{\partial e} - \frac{2}{na} \frac{\partial R}{\partial a}. \quad (6)$$

Because the first term does not contain a small coefficient, the integration of dM/dt requires a solution for a . Again using

$$R = R_c + R_p,$$

where R_c is the constant part of R and R_p is the periodic part, Equation (2) gives

$$a = a_F \left(1 + \frac{2a_F}{\mu} R_c + \frac{2a_F}{\mu} R_p \right) + O(J_2^2); \quad (7)$$

thus, using $n^2 a^3 = \mu$ where there is a J_2 coefficient,

$$\frac{\sqrt{\mu}}{a^{3/2}} = \frac{\sqrt{\mu}}{a_F^{3/2}} - \frac{3}{na^2} (R_c + R_p) + O(J_2^2). \quad (8)$$

Then, dM/dt becomes

$$\begin{aligned} \frac{dM}{dt} &= \frac{\sqrt{\mu}}{a_F^{3/2}} - \frac{3}{na^2} (R_c + R_p) - \frac{(1 - e^2)}{na^2 e} \left[\frac{\partial R_c}{\partial e} + \frac{\partial R_p}{\partial e} \right] \\ &\quad - \frac{2}{na} \left[\frac{\partial R_c}{\partial a} + \frac{\partial R_p}{\partial a} \right] + O(J_2^2). \end{aligned} \quad (9)$$

From Equation (3)

$$\frac{\partial R_c}{\partial e} = \frac{3e}{1 - e^2} R_c, \quad \frac{\partial R_c}{\partial a} = -\frac{3}{a} R_c, \quad \frac{\partial R_p}{\partial a} = -\frac{3}{a} R_p. \quad (10)$$

Therefore,

$$\frac{dM}{dt} = \frac{\sqrt{\mu}}{a_F^{3/2}} + \frac{3}{na^2} R_p - \frac{(1 - e^2)}{na^2 e} \frac{\partial R_p}{\partial e} + O(J_2^2) \quad (11)$$

and the constant part, \bar{n} , of dM/dt , to the first order is

$$\bar{n} = \frac{\sqrt{\mu}}{a_F^{3/2}} \quad (12)$$

the required mean mean motion.

If it is desirable to use the mean value of a , i.e., a_K , then the relation between a_K and a_F , Equation (3), gives for \bar{n} the equivalent formula,

$$\bar{n} = \frac{\sqrt{\mu}}{a_K^{3/2}} + \frac{3}{2} n J_2 \left(\frac{a_e}{a} \right)^2 (1 - \frac{3}{2} \sin^2 i) (1 - e^2)^{-3/2} \quad (13)$$

These formulas ignore terms $0(J_2^2)$ but are valid for all $e < 1$. Equation (13) for \bar{n} is the same to the first order as that obtained by a Von Zeipel transformation solution (Reference 4) of the satellite problem. With the second term on the right multiplied by $-1/2$, it also agrees to first order with Kozai's formula for the mean mean motion (Reference 7.).

THE CONDITION FOR A REPEATING GROUNDTRACK

The criterion for a satellite to have a repeating groundtrack in the mean sense (Reference 5) is:

$$\dot{\omega}_c + \dot{M}_c + s (\dot{\Omega}_c - \dot{\theta}) = 0,$$

where s is orbital frequency and the subscript c denotes secular rate. Using the familiar formulas,

$$\dot{\omega}_c = \frac{3}{4} \frac{n J_2 a_e^2}{(1 - e^2)^2 a^2} (5 \cos^2 i - 1) \quad (14)$$

$$\dot{\Omega}_c = -\frac{3}{2} \frac{n J_2 a_e^2}{(1 - e^2)^2 a^2} \cos i$$

and Equation (12) for \dot{M}_c , we may solve for the required value of a_F by a Newton iteration of

$$f(a_F) = \dot{\omega}_c + \dot{M}_c + s(\dot{\Omega}_c - \dot{\theta}) = 0.$$

This yields the first order value of a_F that satisfies the repeating groundtrack condition. Given the latitude, longitude, and radius of injection, the osculating value of semi-major axis follows at once from Equation (2). Of course, the action of the resonant terms in the geopotential causes an immediate departure from the repeating groundtrack condition. If very high accuracy is required, the value of 'a' can be further improved by iteration of initial conditions using the complete gravitational model. Gedeon (Reference 6) has found this necessary to accurately calculate the stability of synchronous satellites.

CALCULATION OF DRIFT RATES AND BEAT PERIODS

The inverse of the problem of determining resonant orbit elements is finding the drift rate for a satellite with particular orbital elements. As before, a simple comparison of the unperturbed mean motion of the satellite with the rotation rate of the Earth is not sufficient. The effect of the second zonal harmonic on the period of the satellite must be considered. The term "shallow" or near resonance is applied to cases with an amplification of the effects of a term in the geopotential, but not amplified to the extent that the perturbation cannot be accurately calculated as a forced oscillation about a reference trajectory. Gedeon et. al. (Reference 5) refers to this case as one without "feedback."

The small divisor that produces the shallow-resonance effect (Reference 2) is:

$$\dot{D}_{\ell_{mpq}} \triangleq (\ell - 2p) \dot{\omega}_c + (\ell - 2p + q) \dot{M}_c + m(\dot{\Omega}_c - \dot{\theta}) \quad (15)$$

or its square. Kaula (Reference 2) defines the ℓ , m , p , q quantities. Generally, $\dot{D}_{\ell_{mpq}} = 0$ is not equivalent to repeating groundtrack conditions. The conditions are the same only for circular orbits ($q = 0$) and orbits at the critical inclination ($\dot{\omega} = 0$). The "drift rate" $\dot{D}_{\ell_{mpq}}$ or the "beat period" $360^\circ/\dot{D}_{\ell_{mpq}}$ is the meaningful measure of shallow resonance when applied individually to each resonant (ℓ, m, p, q) component.

The significance of these formulas may be illustrated if we consider a hypothetical satellite with elements at epoch:

$a = 1.418358 a_e$
 (period $\sim 1/10$ day)
 $e = .21$
 $i = 55^\circ$, and
 $\omega + M = \Omega = 0^\circ$.

Using Equation (15) to calculate $\dot{D}_{\ell, m, p, q}$ for the principal resonant harmonic component $(\ell, m, p, q) = (11, 10, 5, 0)$, yields

$$\dot{D}_{11, 10, 5, 0} = 1^\circ.8/\text{day (deep resonance)},$$

whereas, a drift rate calculated by comparing the unperturbed mean motion and ten times the rotation rate of the Earth yields the value $22^\circ.5/\text{day}$. This difference will be greatest for a small drift rate. The smaller the drift rate, the greater will be the loss of numerical significance in the calculation of $\dot{D}_{\ell, m, p, q}$. The difference for the larger drift rates (small beat periods) characteristic of shallow resonance is still significant. For example, the GEOS-II satellite with

$a = 1.2086147 a_e$
 $e = .0320360$
 $i = 105^\circ 7768$
 $\omega = 15^\circ 84244$
 $\Omega = 177^\circ 10605$
 $M = 15^\circ 44088$
 $t_0 = 16 \text{ April 1968 } 2^h 9^m 39^s \text{ U.T.C.}$

yielding

$$\begin{aligned}
 \dot{\omega}_c &= -1^\circ 6209/\text{day} \\
 \dot{\Omega}_c &= +1^\circ 3983/\text{day} \\
 \dot{M}_c &= 4619^\circ 0459/\text{day}
 \end{aligned}$$

gives:

$$\dot{D}_{13, 13, 6, 0} = -57^\circ 2/\text{day}.$$

The drift rate calculated from the unperturbed mean motion is

$$\dot{D}_{\text{unper.}} = -75^\circ 0/\text{day}$$

For circular orbits, the beat frequencies are identical for resonant terms of a particular order (m) subscript. Thus, it is impossible to separate the effects of terms such as (13, 13), (15, 13), (17, 13) on a single orbit such as GEOS-II. For eccentric orbits in shallow resonance, there will be several beat frequencies present for each resonant (ℓ , m) term and these can differ substantially. Thus, the possibility of recovering geopotential constants is greater if eccentric orbits are used. Orbits near or at the critical inclination will produce similar or identical beat periods also because a zero perigee rate will also cause all beat periods to be identical for all terms of the same order (m).

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APPENDIX B

PERTURBATION EQUATIONS

Kaula's formulas (Reference 1) were used to calculate the perturbations of the elements discussed in this document. The potential of a planet is defined (Reference 1) as a harmonic series in the mean anomaly, viz.,

$$R_{\ell m} = \mu \frac{a_e^\ell}{a^{\ell+1}} \sum_{p=0}^{\ell} \sum_{q=-\infty}^{+\infty} F_{\ell mp} (i) G_{\ell pq} (e) S_{\ell mpq}$$

where

$$S_{\ell mpq} = \begin{bmatrix} C_{\ell m} \\ -S_{\ell m} \end{bmatrix} \begin{array}{l} \ell - m \text{ even} \\ \ell - m \text{ odd} \end{array} \cos [(\ell - 2p) \omega + (\ell - 2p + q) M + m (\Omega - \theta)]$$

$$+ \begin{bmatrix} S_{\ell m} \\ C_{\ell m} \end{bmatrix} \begin{array}{l} \ell - m \text{ even} \\ \ell - m \text{ odd} \end{array} \sin [(\ell - 2p) \omega + (\ell - 2p + q) M + m (\Omega - \theta)].$$

Kaula (Reference 1) also gives the 1st order solutions to the LaGrange Planetary equations. The solutions applicable to this report are

$$\Delta a_{\ell mpq} = \mu a_e^\ell \frac{2F_{\ell mp} G_{\ell pq} (\ell - 2p + q) S_{\ell mpq}}{na^{\ell+2} [(\ell - 2p) \dot{\omega} + (\ell - 2p + q) \dot{M} + m (\dot{\Omega} - \dot{\theta})]},$$

$$\Delta \omega_{\ell mpq} = \mu a_e^\ell \frac{[(1 - e^2)^{1/2} e^{-1} F_{\ell mp} (\partial G_{\ell pq} / \partial e) + - \cot i (1 - e^2)^{-1/2} (\partial F_{\ell mp} / \partial i) G_{\ell pq}] \bar{S}_{\ell mpq}}{na^{\ell+3} [(\ell - 2p) \dot{\omega} + (\ell - 2p + q) \dot{M} + m (\dot{\Omega} - \dot{\theta})]},$$

$$\Delta \Omega_{\ell mpq} = \mu a_e^\ell \frac{(\partial F_{\ell mp} / \partial i) G_{\ell pq} \bar{S}_{\ell mpq}}{na^{\ell+3} (1 - e^2)^{1/2} \sin i [(\ell - 2p) \dot{\omega} + (\ell - 2p + q) \dot{M} + m (\dot{\Omega} - \dot{\theta})]}$$

$$\Delta M_{\ell_{mpq}} = \mu a_e^\ell \frac{[-(1-e^2) e^{-1} (\partial G_{\ell_{pq}} / \partial e) + 2(\ell+1) G_{\ell_{pq}}] F_{\ell_{mp}} \bar{S}_{\ell_{mpq}}}{na^{\ell+3} [(\ell-2p)\dot{\omega} + (\ell-2p+q)\dot{M} + m(\dot{\Omega} - \dot{\theta})]} +$$

$$- \frac{3\mu a_e^\ell F_{\ell_{mp}} G_{\ell_{mp}} \bar{S}_{\ell_{mpq}} (\ell-2p+q)}{a^{\ell+3} [(\ell-2p)\dot{\omega} + (\ell-2p+q)\dot{M} + m(\dot{\Omega} - \dot{\theta})]^2}$$

The quantity $\bar{S}_{\ell_{mpq}}$ is the integral of $S_{\ell_{mpq}}$ with respect to its argument. The second term in $\Delta M_{\ell_{mpq}}$ has a small quadratic divisor in the resonant case, and therefore, tends to be dominant. However, the remaining terms may be important for many cases, particularly for beat periods of less than 10 days.

Kaula (Reference 1) precisely defines the $F_{\ell_{mp}}$ and $G_{\ell_{pq}}$ coefficients.

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